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PHYSICS AND MATHEMATICS

No. 73

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UDC 681.883.67:534.232

SMALL LOW-FREQUENCY UNDERWATER EMITTERS BASED ON DISCRETE PERIODIC STRUCTURES

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA in Russian Vol 22, No 4, Jul-Aug 81 (manuscript received 3 Jul 79) pp 32-37

KONEVA, M. A., KRAVCHUN, P. N. and CHERNYSHEV, K. V., Acoustics Department, Moscow State University

[Abstract] An investigation is made of hydroacoustic piezoelectric transducers with lumped parameters that have dimensions much smaller than a wavelength of the emitted sound. Low-frequency emitters are considered in which resonant systems are used with active inertial elements and passive elastic components. In this arrangement, the working frequency of the transducer can be considerably reduced by increasing the compliance of the elastic components without increasing dimensions and weight of the passive part of the structure. In addition, the use of oscillatory systems with many digrees of freedom (discrete structures) can give complex frequency responses suitable for multifrequency sonar. The model for analysis is a network of a fixed number of units consisting of piezoelectric inertial elements across which a given voltage is applied, and springs of known stiffness. It is assumed that the end of the first spring is secured to a rigid wall, and the emitting end of the last unit is loaded by a mechanical impedance. All piezoelectric plates are made of the same material with longitudinal piezoelectric effect. Formulas are given for the resonant frequencies of the emitter, and the amplitude of oscillations of the radiating surface. Optimum phase shifts between applied voltages are determined. Experimental results are given for a three-unit emitter, demonstrating the feasibility of using the proposed design for multifrequency applications. Figures 3; references 7: 6 Russian, 1 Western.
[270-6610]

UDC 681.7:534.883

OPTICAL METHOD OF RECONSTRUCTING ACOUSTIC HOLOGRAM OF POINT SOURCE IN INHOMOGENEOUS WAVEGUIDE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 27, No 4, Jul-Aug 81
(manuscript received 5 Jun 80) pp 513-519

ZUYKOVA, N. V. and SVET, V. D., Acoustics Institute imeni N. N. Andreyev,
USSR Academy of Sciences

[Abstract] An analysis is made of a method of reconstructing acoustic holograms recorded in laminarly inhomogeneous media. Acoustic signals that have been converted to electric signals by a multicomponent reception device of a holographic system located in a laminarly inhomogeneous waveguide are sent to a multichannel light modulator (AM or PM) placed on the end of the optical reconstruction system, which is a waveguide. If its parameters are equivalent to the corresponding parameters of the acoustic waveguide, the intensity of the light signal will be maximum in some region of the optical waveguide in virtue of the reciprocity principle. Such an arrangement realizes the idea of wavefront reversal in the optical model of a real medium. The main problem that arises in implementation of the system is the equivalence of the optical model to the real medium. Mathematical analysis of the proposed technique for optical reconstruction of acoustic holograms recorded in inhomogeneous media shows that it is practically realizable from the standpoint of attainable accuracy of manufacture and alignment of all elements of the optical system. Figures 1; references 9: 7 Russian, 2 Western.
[275-6610]

UDC 534.231.1-14

TRANSPARENCY ENHANCEMENT OF NEMATIC LIQUID CRYSTAL LAYER WITH FREE ENDS IN SOUND FIELD

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 27, No 4, Jul-Aug 81
(manuscript received 28 May 80) pp 533-538

KOZHEVNIKOV, Ye. N.

[Abstract] A theory is proposed for enhanced transparency of a nematic crystal layer with free ends when it is compressed by a sonic field. Due to the free ends, compression of the layer is transformed to periodic motion of the liquid along the plates that confine the layer. Nonlinear stresses that arise due to the considerable gradient of tangential motion close to the walls lead to steady-state liquid flow. Viscous stresses due to the velocity gradients of steady-state flow of the nematic crystal lead to rotation of the molecules of the crystal, and hence to increased transparency of the layer. In constructing the theory of this effect, the hydrodynamic variables of velocity, angle of turn

of the molecules, density and pressure are series-expanded with respect to power of the amplitude of compression. From linear hydrodynamic equations at a given compression of the layer, variables of the first order of smallness are found that satisfy the condition of free ends of the layer. This solution is used in deriving equations for steady-state flow of liquid and the angle of turn of the molecules. These equations are then used to find the time-average angle of turn of the molecules, which gives the transparency of the layer. References 16: 6 Russian, 10 Western.
[257-6610]

UDC 534.87.2

HAMILTONIAN APPROACH TO PROBLEMS OF SOUND EMISSION BY MOVING SOURCES OF MASS

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 27, No 4, Jul-Aug 81
(manuscript received 12 Jun 80) pp 539-545

KRASIL'NIKOV, V. A., PAVLOV, V. I. and TREBLER, P. M., Physics Department, Moscow State University imeni M. V. Lomonosov

[Abstract] Most previous research dealing with emission of sound by sources of different physical properties has concentrated on sources moving at constant velocity. By contrast, this paper examines the peculiarities of the emission process that occur when the source is in uniform acceleration. The analysis is based on a Hamiltonian approach that has been extensively used in electrodynamic problems. Equations are derived that describe the motion of the medium with consideration of the mass source distribution characterized by the time behavior of an increment of mass of the substance at a given point of the medium normalized to a unit of volume. Because of the presence of mass sources, the physical system described by these equations is nonconservative. The medium is taken to be a perfect isothermal gas in a homogeneous gravitational field. The given system of equations is rewritten in canonical matrix form, and then represented in normal form for the Hamiltonian description. The solution gives the spectral density of energy for any mode of possible motions in the medium, and also the total energy of the wave field. Disregarding nonlinear wave processes, the authors examine emission of modes belonging to the continuous wave spectrum. Sound emission is considered in homogeneous and inhomogeneous media for various modes of motion of the sources, and the energy characteristics of this radiation are calculated. References 25: 21 Russian, 4 Western.
[257-6610]

UDC 534.286

ANISOTROPY OF ABSORPTION OF ULTRASOUND IN FLOW OF NEMATIC LIQUID CRYSTALS

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 27, No 4, Jul-Aug 81
(manuscript received 18 Jul 79, after revision 10 Oct 80) pp 546-553

LAGUNOV, A. S., NOZDREV, V. F. and PASECHNIK, S. V., All-Union Machine Building Correspondence Institute

[Abstract] Shear deformations that accompany different types of nematic liquid crystal flows can have a considerable effect on orientation. And a change of orientation can lead to localized flows. This interaction leads to effects without analogs in flows of isotropic liquids. Optical methods of studying orientational structure of nematic crystal flows are restricted to low transparency and are applicable to thin specimens where there is strong orienting action of the contacting surfaces. The acoustic method is used in this paper, enabling investigation of shear-induced orientation of nematic liquid crystals in volumes considerably exceeding the magnetic coherence length. The time of orientational relaxation in this case is a function of volume, and depends only on the material constants of the liquid crystal. Experiments are described in which the acoustic method is used to study a flow of the nematic liquid crystal methoxy-benzylidine-p-r-butylaniline (MBBA). It is found that propagation of ultrasound in such flows conforms to Leslie-Ericksen hydrodynamics with consideration of the existence of anisotropic coefficients of volumetric viscosity. Figures 4; references 15: 1 Russian, 14 Western.
[275-6610]

UDC 534.26

SOUND EMISSION BY SANDWICH PLATE WITH LIQUID MIDDLE LAYER AND STIFFENING RIBS

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 27, No 4, Jul-Aug 81
(manuscript received 6 Jun 80) pp 573-579

ROMANOV, V. N.

[Abstract] An analysis is made of the radiation of sound by three-layer plates reinforced by inner stiffner ribs (between layers), and by outer ribs on one of the elastic layers when the other outer layer is excited by a force applied at a point. It is assumed that the thicknesses of the elastic layers and ribs are much less than a wavelength of the sound stimulated in them, that the applied force is linear, that the elastic layers are subject to bending vibrational motion only, and that the stiffener ribs can vibrate only longitudinally. The liquid medium in the upper and lower half-spaces and between the layers has identical density and speed of sound. Solutions are found that satisfy differential equations of flexural vibrations of the layers with consideration of the reaction of the stiffener ribs to these vibrations, the Helmholtz equation in

the liquid, boundary conditions on the surfaces of the elastic layers and contact conditions at points of joining of the inner rib to the elastic layers. Ratios of average pressures to the force applied to the plate are calculated for the three-layer and one-layer cases. It is found that sound emission by unribbed three-layer and one-layer plates practically coincides on lower and middle frequencies. An inner rib in a three-layer plate has almost no effect on increasing acoustic pressure in the liquid on lower and middle frequencies. A single-layer plate with the same rib gives an appreciable contribution to the acoustic field. At high frequencies, the maximum pressures in the liquid due to outer and inner ribs are about the same. Figures 3; references 9: 7 Russian, 2 Western.
[257-6610]

UDC 534

SOUND WAVE SCATTERING BY THIN ACOUSTICALLY STIFF BODY OF REVOLUTION

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 27, No 4, Jul-Aug 81 (manuscript received 23 Jan 80) pp 605-609

FEDORYUK, M. V., Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences

[Abstract] The author considers the problem of scattering of a plane wave incident on a thin body of revolution in a homogeneous isotropic liquid or gas, assuming that the length of the body is of the order of a wavelength, and that its thickness is much less than a wavelength. Asymptotic expansions are found for the scattered field. It is shown that the principal term in the asymptotic form of the scattering amplitude is not affected by the limitation of these approximations in the vicinity of the edge of the body. Approximate formulas for the field close to the body can be obtained by approximating the surface by a paraboloid of revolution. References 9: 8 Russian, 1 Western.
[257-6610]

UDC 534

CALCULATING TRAJECTORIES OF ACOUSTIC BEAMS WITH CONSIDERATION OF OCEAN CURVATURE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 27, No 4, Jul-Aug 81 (manuscript received 3 Apr 80) pp 628-629

SUKHORUKOV, V. I. and SUKHORUKOV, G. I., Irkutsk Polytechnical Institute

[Abstract] Equations that account for the influence of ocean curvature on the trajectories of acoustic beams are derived from the relation used for determining

the angle of astronomic refraction and trajectories of radio beams in the earth's atmosphere. An exact solution is found. Expressions are given for the depth of the beam trajectory at any instant, and for the maximum depth of the trajectory. Calculations by the proposed formulas are compared with calculations of the cycle length, maximum depth of penetration and cycle time for a plane-parallel medium. The result shows that accounting for curvature improves accuracy by 1.3-1.4%. Figures 2; references 4 Russian.
[257-6610]

UDC 621.373.826:531.21

THERMOCHEMICAL EFFECTS IN RADIATION EROSION OF GALLIUM ARSENIDE

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 7, Jul 81
(manuscript received 11 Jun 80) pp 1468-1477

LIBENSON, M. N., OKSMAN, Ya. A. and SEMENOV, A. A.

[Abstract] Experiments are done to study the morphology of radiation damage of gallium arsenide. The specimens were single-crystal plates 6 mm thick, the surfaces coinciding with plane <111>. Radiation of a TEA CO_2 laser with pulse duration of 150-200 ns was focused on the polished surface of the specimens. The effective spot diameter on the specimen was about 0.25 mm. Pulse power was controlled by optical filters. Damage morphology was studied by a scanning electron microscope. Analysis of the erosion process was based on a model that assumes development of local thermal instability as a result of dissociation of gallium arsenide and formation of a gallium-enriched absorbing layer. The validity of this model is confirmed by calculations of the threshold of instability, and also by observations of the dynamics of development of radiation damage, as well as the morphology of this damage. A "fatigue" effect that is typical of thermochemical processes is observed with repeated pulse action. Figures 1, tables 2, references 14: 13 Russian, 1 Western.
[258-6610]

FLUID DYNAMICS

UDC 533.6.011.72

INTERACTION BETWEEN OVERTAKING SHOCK WAVE AND CYLINDER MOVING AT SUPERSONIC VELOCITY

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 7, Jul 81
(manuscript received 17 Apr 80, after revision 21 Oct 80) pp 1458-1462

SADYMENKO, T. P. and YAKUBOV, I. R., Tashkent Polytechnical Institute
imeni A. R. Beruni

[Abstract] Interaction of an overtaking shock wave with bodies of different shapes gives rise to a complicated pattern of unsteady flow that is extremely difficult to calculate even with modern computers. In this paper, some results are given on a physical study of interaction between a planar overtaking shock wave and a cylindrical body moving at supersonic speed in an unbounded flow. Although the presentation is intended mainly to illustrate the capabilities of the method of gas-hydraulic analogies, some results may be directly applicable to investigation of flow patterns and even to practical calculations. The analog experiment was done by towing a model through a shallow layer of water. A wave generator was used to simulate the overtaking shock wave. Motion pictures were taken as soon as the overtaking wave was 1.5-2 diameters behind the critical trailing edge of the cylinder. Analysis shows four stages of the process: 1. interaction of the overtaking shock wave with the tail compression shock and with flow in the base region; 2. transition of the interacting tail compression shock and the overtaking shock wave to the surface of the cylinder; 3. overtaken interaction of shock fronts with oblique incidence; 4. straight shock wave departing ahead of the cylinder. Limitations of the technique are discussed. Figures 8, references 5 Russian.
[258-6610]

UDC 551.511.6:532.516

STRUCTURE OF DETACHED FLOW BEHIND BLUFF BODY

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA in Russian Vol 22, No 3, May-Jun 81 (manuscript received 19 Jun 79) pp 71-75

ANISIMOVA, Ye. P., SPERANSKAYA, A. A. and SHAPKHAYEV, S. G., Department of Physics of the Sea and Inland Water, Moscow State University imeni M. V. Lomonosov

[Abstract] Experiments are done to determine the structure of the velocity field that arises in detached flow behind an isolated roughness in a closed wind tunnel with open elliptical working section 4 m long. The model is a half-cylinder mounted on the horizontal surface of a table in such a way that the axis of the model is perpendicular to the incident airflow. The degree of input turbulence of the flow in the working section of the tunnel is 0.2%, and the Reynolds number is $2.1 \cdot 10^5$. A special anemometer was used for simultaneous determination of horizontal and vertical components of the flow velocity, with synchronous registration of the mean-velocity profile and the horizontal and vertical pulsations of the flow. The results are used to plot vertical profiles of the horizontal velocity component, and a diagram of the vector field of velocity of the air flow around the model. It is found that zones of separation occur before and after the model. In the detached flow behind the half-cylinder is a mixing layer where the vertical profiles of the longitudinal mean-velocity component are similar to the mean-velocity profile in a plane turbulent mixing layer right up to the zone of reattachment. Measurements show considerable inhomogeneity of the distribution of integral turbulence characteristics in the longitudinal direction in the region of detached flow. Analysis of autospectra of velocity pulsations reveals two statistically significant maxima in the zone of detachment behind the half-cylinder corresponding to Strouhal numbers of 0.013-0.018 and 0.031-0.036. Figures 4, references 8: 5 Russian, 3 Western.
[255-6610]

LASERS AND MASERS

UDC 536.3

INVESTIGATION OF POWER DISTRIBUTION OF INTERNAL HEAT SOURCES IN ILLUMINATOR ELEMENTS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian
Vol 24, No 8, Aug 81 (manuscript received 10 Jun 80) pp 92-96

[Article by L. A. Savintseva, A. V. Sharkov, V. G. Parfenov and V. A. Cur'yanov,
Leningrad Institute of Precision Optics and Mechanics]

[Text] The most significant factors that determine the power distribution of an internal heat source in an active element are explained in accordance with data of analysis of calculations done by a program based on a Monte Carlo method.

In designing illuminators, it is important to analyze the temperature conditions of their operation based on calculations. One of the major stages of the calculation is determination of the distributions of volumetric heat sources that arise in illuminator components as pumping radiation is absorbed. An approximate method was proposed in Ref. 1 for calculating integral powers of internal heat sources in individual elements. It was assumed that the radiation is isotropically incident on the surface, and that energy is uniformly distributed within these elements. However, such assumptions are rather rough for detailed investigation of the temperature fields of individual illuminator components since energy is distributed nonuniformly within the active element even when radiation is isotropically incident on its surface because of attenuation in the medium and refraction on the lateral cylindrical surface [Ref. 2].

This article gives the results of calculation of the distribution of surface flux density incident on an active element, and also the distribution of power of volumetric heat sources in the active element in accordance with a program based on a Monte Carlo method, revealing the most significant factors that determine the nature of these distributions. The Monte Carlo method was also used in calculating pumping systems in Ref. 3, 4.

The algorithm and program of calculation on a digital computer have been developed for a class of illuminators that are now in wide use, in which the pumping lamp 2 is placed parallel to the axis of active element 1 (Fig. 1). Various modifications of such a design are possible. Channels 3, 4 that carry coolant or liquid filters can be placed around the active element and pumping lamps. Illuminators 5 may be of monoblock design with specular or diffuse reflective coating. The surface of the active element may be polished or dull. One or more pumping lamps may be placed around the active element.

It was assumed in the calculation that the plasma of the pumping lamp is transparent to self-radiation, and that emission of the lamp is incident on the active element in the direction perpendicular to its axis (i. e. the planar problem was considered).

The process of radiation modeling begins with the surface of the lamp envelope. It is assumed that this envelope radiates in accordance with Lambert law. Energy radiated by the lamp in wave band d_λ can be determined from the spectral curve of radiation of the lamp [Ref. 5].

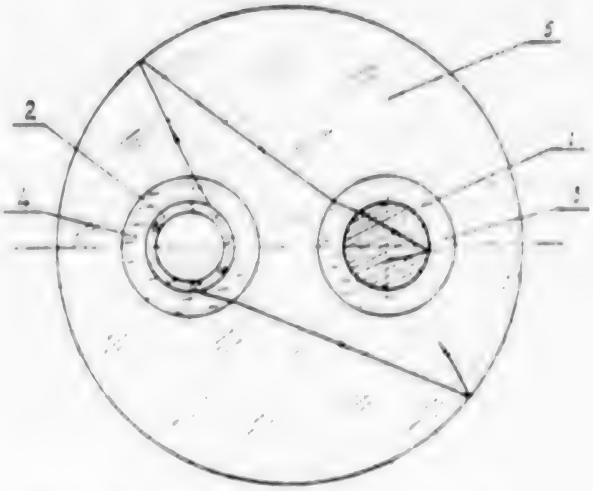

Fig. 1. Schematic diagram of illuminator design

The given spectral energy is transported by N beams of energy. In the process of tracing these beams, consideration is taken of laws of refraction, reflection and absorption. Beam travel is traced up to the point where the beam of energy is absorbed in the given system.

Thus, the initial data for the calculation are: the structure and geometry of the illuminator, the indices of refraction of the media under consideration, and the spectral distribution of lamp radiation energy. The calculations were done for the system shown in Fig. 1. The reflector of the illuminator is a cylindrical quartz monoblock of diameter d_0 with specular or diffuse reflective coating and spectral reflectivity R, index of refraction n_0 and spectral coefficient of absorption of the monoblock K_0. The pumping lamp is a cylinder of diameter $d_б$, and the external surface of the lamp is cooled by a heat-transfer agent with index of refraction $n_{жб}$ and spectral coefficient of absorption $K_{жб}$. The active element is a cylinder with diameter d_a, index of refraction n_a and spectral coefficient of absorption K_a. The outer surface of the active element is polished and cooled by a fluid with index of refraction $n_{жа}$ and spectral coefficient of absorption $K_{жа}$. The distance between the centers of active element and pumping lamp is l. The Table summarizes the numerical values of the parameters used in the calculations.

TABLE

Illuminator №	d_0, мм	d_a, мм	$d_б$, мм	$d_{жа}$, мм	$d_{жб}$, мм	l, мм	R	K_0, 1/мм
1	40	8 4	8	12	12	14	0.5–0.95	0
2	28	5	5	6	12	12	0.5–[illegible]	0
3	28	[illegible]	[illegible]	6	12	12	0.7	0.01

[table continued on following page]

[continuation of table from preceding page]

K_a, 1/мм	$K_{жб}$, 1/мм	$K_{жз}$, 1/мм	n_a	$n_б$	$n_{жб}$	$n_{жз}$	Coating
0,1	$0.1 \cdot 10^{-3}$	$0.1 \cdot 10^{-3}$	1,53	1,93	1,33	1,33	Specular
0,07	0	0	1,5	1,93	1,33	1,33	Specular and diffuse
0. 7	0	0.02	1,5	1,93	1,0	1,33	Specular

Based on the results, an examination is made of the influence of different factors on the transfer coefficient of the illuminator (the ratio of the energy that reaches the active element as a result of multiple reflections from the surface of the reflector, to the energy radiated by the lamp), on the degree of nonuniformity of the distribution of surface flux density on the active element, and on the nature of distribution of power of an internal heat source of the active element.

Analysis of the results showed that the most significant factors influencing the transfer coefficient are: reflectivity and type of reflective coating, relative placement and dimensions of lamp and active element.

Fig. 2 shows the dependence of the transfer coefficient of the illuminator monoblock on reflectivity of the specular coating of the reflector, and also on the ratio of diameters of active element and pumping lamp. The calculation used data given for illuminator 1 in the Table. The spacing between centers of the active element and pumping lamp has a considerable effect on the transfer coefficient. As their axes approach and the intercenter spacing changes (see data for illuminators 1 and 2 in the Table), the transfer coefficient increases by 16%.

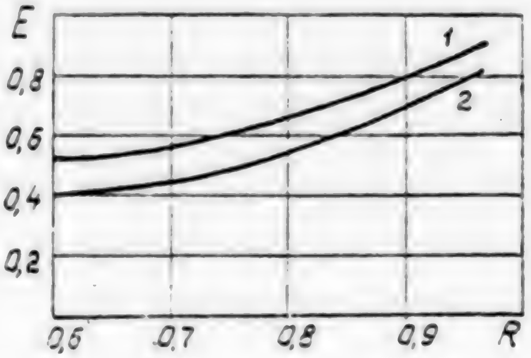

Fig. 2. Transfer coefficient of illuminator as a function of reflectivity of specular reflector coating

$1 - \frac{d_a}{d_л} = 1$; $2 - \frac{d_a}{d_л} = 0.$[illegible]

Studies have shown that use of a diffuse reflective coating reduces the transfer coefficient. For example, when the specular reflective coating is replaced by a diffuse coating (see illuminator 2 in the Table), the transfer coefficient decreases by 15%. The relative error of calculation of the transfer coefficient in the assumed thermal and mathematical model did not exceed 5% at a confidence coefficient of 99.9% [Ref. 6, 7].

Investigation of the nature of distribution of the surface density of the flux incident on the active element showed that this distribution depends strongly on the geometry of the elements of the system, on the reflectivity of the reflector, and on the type of reflecting surface (specular or diffuse).

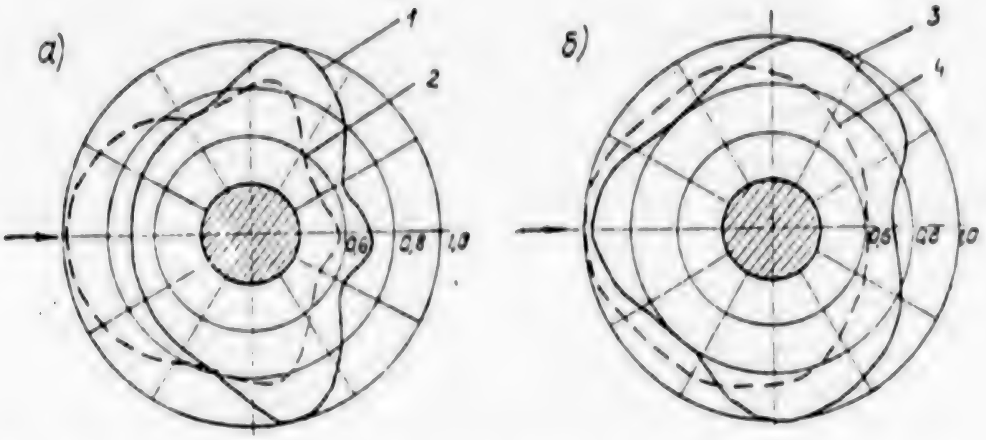

Fig. 3. Distribution of surface density of flux incident on the active element as a function of reflectivity (a) and type of reflective coating (b):
(→ indicates the direction of lamp radiation)
1--$R = 0.9$; 2--$R = 0.6$; 3--specular reflective coating;
4--diffuse reflective clating

Fig. 3a shows the angular dependence of the distribution of surface density of the flux incident on the active element as a function of the reflectivity of the reflector. For purposes of clarity, the diagram shows the ratio of the instantaneous value of the density to the maximum value on the surface of the active element. As we can see from Fig. 3a, the incident flux density depends rather strongly on the angular coordinate.

The influence of lamp radiation shows up most strongly at lower reflectivities. Displacement of the maximum of surface density of the incident flux in the direction of the pumping lamp is also observed as the distance between the axes of the active element and lamp decreases. Diffuse reflective coatings give somewhat more uniform distribution (Fig. 3b). At the same time, this type of coating reduces the surface density of the incident flux on the shaded part of the active element.

Let us consider the distribution of power of an internal heat source in the active element. Fig. 4a (see Table, illuminator 3) shows the distribution of surface density of the incident flux, and Fig. 4b shows the distribution of power of internal heat sources in the active element. The contour lines map equal volumetric energy density in the active element. Here we can see a trend toward displacement of the maximum power of an internal heat source toward the pumping lamp.

The program running time is appreciably dependent on the efficiency of the system, on the coefficient of absorption of the media considered, etc. For the investigated illuminators, the running time for one spectral interval ranged from 10 to 30 min (the value of N reached 3600).

Experimental verification of nonuniformity of the distribution of surface density of the flux incident on the active element showed satisfactory agreement with calculations. The results given in this paper demonstrate that the distribution of

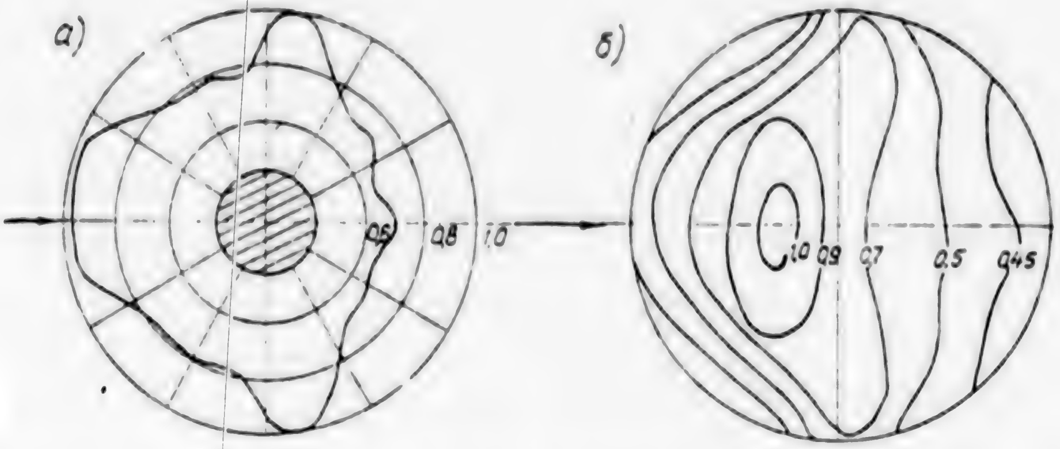

Fig. 4. Distribution of surface density of incident flux (a) and power of internal heat sources (b) in active element (→ indicates direction of lamp radiation)

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CSO: 8144/036

UDC 551.573

PROPAGATION OF PHOTOTROPISM WAVE THROUGH NONHOMOGENEOUS FLAMMABLE AEROSOL

Novosibirsk ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI in Russian
No 4, Jul-Aug 81 (manuscript received 9 Jun 80) pp 76-83

BASHKIROVA, N. P. and SAGALAKOV, A. M., Barnaul

[Abstract] Propagation of intense optical radiation through a flammable carbon aerosol is analyzed with the combustion characteristics of a carbon particle taken into account. Almost instantaneous ignition will occur, accordingly, at a sufficiently high radiation intensity which can be determined from the equation of heat balance. The distribution of radiation intensity in a half-space containing flammable aerosol particles is described by Burger's law for a given concentration distribution characterizing the aerosol nonhomogeneity. Determining the phototropism wave front (boundary between already burning and not yet burning particles) and its propagation involves the solution of an integrodifferential equation in one space coordinate and time. It is solved with the aid of an auxiliary time function which satisfies the corresponding plain integral equation in time only and is the original of a well known Laplace transform. The necessary inverse Laplace transformation requires only the standard solution of an integral equation of the first kind. The problem reduces to an ordinary nonlinear differential equation with separable variables. The velocity of the wave front calculated on this basis has generally a jump of the first kind at time $t = t_0$ at which a loss of analyticity occurs. Calculations based on Boltzmann distribution of aerosol particles along the propagation path and on the diffusion model of combustion, where the particle radius squared decreases linearly with time, yield results which are in satisfactory agreement with available data on carbon aerosol and indicate the possibility of intense phototropism. In a polydisperse aerosol the phototropism wave front is found to be diffuse in the form of a moving region of finite width which separates the region of only burning particles from the region of only not burning particles and contains a mixture of both. Figures 2, references 9: 7 Russian, 1 Western.
[13-2415]

UDC 621.375.826

CHARACTERISTICS OF GAS-DISCHARGE CO-LASER AS HARMONIC OSCILLATOR, PART 2: SIMULTANEOUS EMISSION AT FUNDAMENTAL FREQUENCY AND SECOND HARMONIC IN PULSE MODE

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 41, No 3, Sep 81 (manuscript received 10 Jun 80) pp 514-519

KONEV, Yu. B., KOCHETOV, I. V., KURNOSOV, A. K., PEVGOV, V. G. and DEM'YANOV, A. V., Institute of High Temperature, USSR Academy of Sciences, Moscow

[Abstract] The performance of a gas-discharge CO-laser with second-harmonic emission in the pulse mode is analyzed theoretically, of particular interest being the effect of simultaneous emission at the fundamental frequency. The equations of kinetics describing the change in populations of vibrational levels at two different transitions are supplemented with terms which account for the rates of induced VV-exchange and VT-relaxation processes. The maximum second-harmonic gain is calculated as a function of the threshold fundamental emission for a CO:Ar=1:10 laser at 100 K with a pumping pulse of typical 30 μs duration. Also calculated are the intensities of fundamental and second-harmonic emission during and after the pumping pulse, the second-harmonic intensity peaking much later with a short small overshoot after the end of the pumping pulse. An examination of the emission spectrum reveals that its short-wave edge and peak occur at higher levels than in the case of second-harmonic emission alone, the shift becoming larger as the fundamental emission increases. They also shift toward higher levels with increasing temperature. While the conversion efficiency decreases with increasing temperature during second-harmonic emission alone, it also decreases with decreasing temperature as simultaneous fundamental emission increases. On the other hand, second-harmonic emission has almost no effect on fundamental emission. There thus exists an optimum temperature, from the standpoint of second-harmonic emission, close to the temperature at which the fundamental gain is equal to the threshold gain (~150 K). Figures 4, references 7: 6 Russian, 1 Western.
[16-2415]

UDC 535.361

LIGHT FIELD BEYOND GEOMETRICAL ZONE OF LASER BEAM PROPAGATION THROUGH LAYER OF SCATTERING MEDIUM

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 35, No 3, Sep 81 (manuscript received 18 Aug 80) pp 523-527

VOYSHVILLO, N. A.

[Abstract] A theoretical analysis of the light field of a narrow Gaussian laser beam passing through a layer of a scattering medium perpendicular to the

beam axis yields a mean intensity which varies radially according to the law $E_m = E_0e^{-cr^2}$ (coefficient c being independent of the radius r but a function of the distance traversed and of the correlation length). An experimental study with four grades of frosted glass does not confirm this. An evaluation of the data yields the empirical law $E_m = E_0 + \frac{b}{r^2}$. The scatter spot, accordingly, can be regarded as a secondary source of light whose intensity varies according to the inverse-square law with the distance in any radial direction. Figures 3, references 6: 5 Russia , 1 Western.
[15-2415]

UDC 535.34:621.375.8

PHOTOTROPIC EFFECT IN INJECTION LASERS BY INTRACAVITY SPECTROSCOPY

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 35, No 3, Sep 81
(manuscript received 9 Oct 80) pp 429-435

VORONIN, V. F., GRIBKOVSKIY, V. P., PAK, G. T., RYABTSEV, G. I. and YASHUMOV, I. V.

[Abstract] The method of intracavity spectroscopy was used for detecting absorption saturation in epitaxial layers of injection heterolasers. The indicator was the peak of the concentration of excess current carriers at a critical radiation flux density. A laser diode with a GaAs-$Al_xGa_{1-x}As$ twin heterostructure was placed inside the resonator cavity of a He-Ne laser, between an image converter and a quartz lens followed by an interference mirror (wavelength $\lambda = 0.63$ μm). The equipment behind the He-Ne gas-discharge tube included a plane mirror, a Ge filter plate, a PbS photoreceiver, an amplifier and an oscilloscope. The modulation depth of probing infrared radiation passing through such a heterolayer was measured as a function of the pumping current. Also the luminescence spectra after degradation and the dependence of the peak wavelength on the magnitude of the pumping pulse were measured. The results can be explained by the phototropic or "bleaching" effect in heterolasers with a strip geometry. An increase of the excitation level causes the peak wavelength to become longer. In specimens without this effect, on the other hand, an increase of the excitation level causes the peak wavelength to become shorter and eventually stabilize. Figures 4, references 14: 8 Russian, 6 Western.
[15-2415]

UDC 621.375.8

RING LASER WITH ORTHOGONALLY POLARIZED OPPOSITELY TRAVELING WAVES

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 35, No 3, Sep 81
(manuscript received 24 Mar 80) pp 425-428

SHEVTSOVA, A. I.

[Abstract] Various measurements require a ring laser with oppositely traveling waves polarized in orthogonal planes. Here, for differential methods or simultaneous measurement of two parameters, a 4-wave ring laser is considered with polarization of the two pairs of oppositely traveling waves in orthogonal planes. In one scheme the isotropic resonator cavity contains two crossed quarter-wave plates and a Faraday element between them. In another scheme the optical axes of both plates lie either in the plane of the resonator or in a plane perpendicular to it and the polarization planes of natural modes are at ±45° to the plane of the resonator. The first scheme was stuided experimentally with the isotropic resonator cavity formed by three mirrors and an oblique plane-parallel half-wave quartz plate for compensation of amplitude anisotropy. Two helium-neon discharge tubes (wavelength $\lambda = 1.15$ μm) with transillumination windows perpendicular to one another were used as active elements. It has been established that at every gain level there exists a corresponding critical magnitude of amplitude anisotropy above which only a wave with one polarization appears in each direction, the wave with the other polarization being suppressed. Figures 2, references 3 Russian.
[15-2415]

UDC 621.375.8

HIGH-FREQUENCY SELF-MODULATION OF RADIATION FROM TWO-MIRROR LASER WITH NONLINEAR DELAY ELEMENT

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 35, No 3, Sep 81
(manuscript received 25 Apr 80) pp 421-424

LOYKO, N. A. and SAMSON, A. M.

[Abstract] A nonlinear delay element in the resonator cavity of a traveling-wave 2-mirror ring laser is considered as means of high-frequency self-modulation, generating a pulse sequence at the frequency of intermode beats or a multiple thereof. The fine time structure of the radiation, which depends on the ratio of the delay time to the period of photon circulation in the resonator, is analyzed on the basis of appropriate kinetic equations which take into account the configuration of resonator components and the presence of oppositely flowing photon fluxes. The results, generally obtainable by a numerical method of solution only, indicate the dependence of the laser performance and stability regions on the position of the nonlinear element such as a shutter with feedback control relative to the mirrors. Figures 2, references 4 Russian.
[15-2415]

UDC 621.373.826

SMALL MOLECULAR NITROGEN POWER LASER FOR PUMPING TUNABLE DYE LASERS

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 35, No 2, Aug 81
pp 220-222

ERDEVDI, N. M., ZINEVICH, Ye. M. and POPADINETS, Yu. Yu.

[Paper delivered at the Third All-Union Conference on Dye Lasers and Their Applications, 10-12 September, 1980, Uzhgorod]

[Abstract] Although many designs are available for nitrogen lasers with transverse discharge, Soviet industry has not begun producing nitrogen lasers that are reliable, compact, convenient and simple to use. Some of the reasons for this are the use of spark gaps for commutation, swkward and complex thyratron control systems, and cumbersome and complicated pumping units. This paper describes the construction of a nitrogen laser channel, a simple compact thyratron control circuit and a reliable high-voltage pumping module that eliminate these drawbacks to a great extent. All systems are accommodated in a single housing measuring 480x420x198 mm. The laser channel is formed by brass electrodes 380 mm long and 4 mm wide separated by a gap of 14 mm. Installed directly on the electrodes along the channel are 22 KVI-3 capacitors (470 pF, 20 kV). The electrodes are in an evacuated space between lucite walls sealed off by rubber gaskets. A quartz window normal to the channel axis is located at the output end, and at the opposite end is a quartz window at an angle of 6-8° to the normal, behind which is a 98% dielectric mirror in an adjustable holder. The thyratron placement is such that the exciting pulse is almost entirely determined by the parameters of the discharge circuit and by the channel itself rather than by the thyratron. The voltage applied to the electrodes of the laser cell is about 15 kV, and the optimum nitrogen pressure is 40-60 mm Hg. Specific pulse owoer is about 25 kW/cm^3, and the emission pulse duration at half-amplitude is 8 ns. Dimensions of the laser beam are 14 x 5 mm, and divergence is no worse than 8 mrad in the electrode plane, and 3 mrad in the perpendicular plane. Lasing power is 400 kW at a pulse recurrence rate of 20 Hz. Figures 2, references 1 Russian.
[265-6610]

UDC 621.378.35

DEFECT FORMATION IN ACTIVE REGION OF HETEROLASERS AND CHANGE OF INTERNAL PARAMETERS

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 35, No 2, Aug 81
(manuscript received 31 Oct 80) pp 272-279

VORONIN, V. F., ZHUKOV, N. D., KONONENKO, V. K., RYABTSEV, G. I. and SOSNOVSKIY, S. A.

[Abstract] Although the principal features of gradual degradation of LEDs have been fairly well researched, and the pattern of development of defects has

been analyzed in detail by electron microscope, we still do not have the complete story on the way that these defects influence the deterioration of energy characteristics of the diodes. The channels of energy losses due to defects in degrading injection lasers can be determined by measuring internal laser parameters. In this paper a general analysis is made of the kinetics of gradual degradation of heterolasers and the behavior of their internal parameters. The properties of incipient defects are discussed on the basis of the results. It is assumed that degradation is due to the formation of nonradiative and absorbing defects in the active region. Internal parameters and their time behavior are studied by placing the laser diodes in immersion fluids. The proportional contributions of the various channels of energy loss to the drop in lasing power on various stages of operation of a semiconductor laser are determined by analyzing the resultant data. It is found that nonradiative defects play a major part on the initial stage of degradation. Absorbing defects with light absorption cross section of the order of $2 \cdot 10^{-17}$ cm^2 become important on later stages. Figures 2, references 18: 15 Russian, 3 Western.
[265-6610]

NONLINEAR EFFECTS IN STIMULATED EMISSION OF ION LASERS

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 81, No 2(8), Aug 81 (manuscript received 12 Jan 81) pp 457-467

SMIRNOV, G. I. and SHAPIRO, D. A., Institute of Automation and Electrometry, Siberian Department, USSR Academy of Sciences

[Abstract] An ion laser theory is outlined that has a number of important differences from W. E. Lamb's gas laser theory because it takes consideration of the influence that the energizing discharge field has on translational motion of ions. An examination is made of the effect of the discharge field on the spectrum and frequency characteristics of ion laser emission. An investigation is made of the part played by strong saturation and intermode interaction in formation of the lasing pattern. The analysis is based on a model of an axially symmetric laser emitting on a known frequency. Criteria of stability are found for different lasing modes. It is found that acceleration effects produce sequential alternation of single-mode and two-mode lasing. The action of plasma fields on the profile of the Lamb shift in the lasing spectrum is studied. It is shown that ion acceleration can result in a change from energy pushing to energy pulling of the lasing frequency. In an ion ring laser, the electric field of the discharge may cause frequency splitting of two opposed waves of unequal intensity due to the different nonlinear frequency pushing effects. It may be possible to use this effect for stabilizing the frequency of stimulated emission of an ion laser with respect to the center of the amplification line. Figures 3, references 19: 13 Russian, 6 Western.
[264-6610]

UDC 621.373.7

FIVE-WAVE COHERENT RAMAN MIXING MODEL

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA in Russian Vol 22, No 4, Jul-Aug 81 (manuscript received 9 Jul 79) pp 52-58

D'YAKOV, Yu. Ye., NEKHAYENKO, V. A. and NIKITIN, S. Yu., Department of General Physics and Wave Processes, Moscow State University

[Abstract] Previous research on the theory of coherent Raman mixing has been based on a four-wave model of interaction assuming that the sampling radiation signal is scattered by oscillations of the medium only into the Stokes or anti-Stokes region. Although this model is valid for strongly dispersing media such as calcite, the use of media with relatively weak dispersion such as compressed hydrogen has a number of advantages for coherent Raman mixing, including high efficiency of frequency conversion and a broad emission tuning range. It has been shown that simultaneous scattering into both regions is possible in this case, and therefore the authors consider a five-wave model for experimental identification of the coherent Raman mixing process. The model is analytically and numerically studied for stimulated emission of tunable infrared radiation in hydrogen. It is shown that accounting for the fifth wave radically alters the pattern of interaction due to intense transfer of energy to this wave. An approximate solution is found for equations of coherent Raman mixing, enabling calculation of the efficiency of frequency conversion as a function of field frequencies, gas pressure and pumping intensity. Figures 4, references 9: 5 Russian, 4 Western.
[270-6610]

UDC 621.373.7

COHERENT RAMAN MIXING WITH SIMULTANEOUS EXCITATION OF FORWARD AND REVERSE RAMAN WAVES

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA in Russian Vol 22, No 4, Jul-Aug 81 (manuscript received 16 Oct 80) pp 81-84

D'YAKOV, Yu. Ye. and NIKITIN, S. Yu., Department of General Physics and Wave Processes, Moscow State University

[Abstract] The efficiency of generation of infrared radiation in coherent Raman mixing is determined by the parameters of molecular vibrations that arise with the stimulated Raman effect. Previous calculation of these parameters has assumed scattering only in the forward direction. Since intense backscattering arises with a pumping pulse duration of 10^{-8}-10^{-9} s, the distribution of molecular vibrations is considerably altered by the appearance of a reverse Stokes component that in turn changes the efficiency of infrared emission. A theoretical analysis of this effect is made in this paper. A solution is

found for the system of equations that describes stimulated Raman scattering in the presence of forward and reverse Stokes components. It is shown that the model that accounts for scattering in both directions is more adequate for description of experimental results than the model that assumes scattering in only the forward direction. An experiment is suggested for verifying the calculations by placing an additional cell with scattering substance on the path of the pumping and sampling beams to act as a preamplifier of the accompanying Stokes component. Figures 2, references 7: 3 Russian, 4 Western.
[270-6610]

ELECTROMAGNETIC THEORY OF GIANT AMPLIFICATION OF RAMAN LIGHT SCATTERING BY ADSORBED MOLECULES

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 34, No 4, 20 Aug 81 (manuscript received 9 Mar 81, after revision 27 Apr 81) pp 157-161

GOROBEY, N. N., IPATOVA, I. V. and SUBASHIYEV, A. V., Physicotechnical Institute imeni A. F. Ioffe, USSR Academy of Sciences

[Abstract] Experimental studies of Raman scattering of light by molecules adsorbed on the surface of different metals has shown that the scattering cross section in this case is five or six orders of magnitude greater than for scattering by the same molecules in the pure material. As electromagnetic waves propagate in an inhomogeneous medium, field amplification takes place close to the point where permittivity vanishes. In this paper it is shown that this effect can explain "giant" amplification of Raman scattering of light. Since the characteristic dimensions of the surface relief are much smaller than a wavelength of visible light, the authors introduce the concept of a surface transition layer with effective permittivity that depends on distance from the metal surface and is constant perpendicular to this distance. The permittivity in this layer ranges from 1 at the interface with vacuum to a large negative value in the metal. Close to the point where permittivity vanishes, the dependence on distance can be taken as linear. Thus the analysis is based on a laminar model of vacuum, linear layer, and metal. Oblique incidence of the light wave is assumed, with polarizaiion in the plane of incidence. An expression is derived for the time-averaged intensity of the scattered light into an elementary solid angle, and it is shown that scattering due to molecules adsorbed on the surface introduces a factor equal to the cube of the ratio of the real to the imaginary component of the permittivity in the metal. This factor does not exceed the cube of the ratio of thickness of the transition layer to the average size of the given molecules, and is absent in the case of a smooth surface. The analysis is confirmed by experimental data. References 10: 5 Russian, 5 Western.
[2-6610]

He-Ne/CH_4 LASER FREQUENCY MEASUREMENT

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 34, No 4, 20 Aug 81 (manuscript received 18 Jun 81) pp 175-178

DOMNIN, Yu. S., KOSHELYAYEVSKIY, N. B., TATARENKOV, V. M. and SHUMYATSKIY, P. S., All-Union Scientific Research Institute of Physicotechnical and Radiotechnical Measurements

[Abstract] A report on the most exact measurements of the frequency of a helium-neon laser stabilized with respect to the F_2^2 component of methoae. The relative error of the measurements is within $1.6 \cdot 10^{-11}$. The measurement facility was based on a multiplicative laser chain in which submillimeter lasers were phase-synchronized with a calibrated standard, and the infrared lasers were synchronized with the He-Ne/CH_4 laser. In this way the multiplicative chain was totally synchronized, and the measurements were made at only one point. Measurements were made by spectrum analyzers and frequency meters in six series over a three-month period from February to May of 1981. With consideration of all corrections, the frequency of the He-Ne/CH_4 laser was found to be 88 376 181 603.4 ± 1.4 kHz. Figures 2, references 6: 1 Russian, 5 Western.
[2-6610]

UDC 533.95

NUMERICAL STUDY OF DYNAMICS OF AEROSOL MICROFLARE IN A LIGHT FIELD

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 7, Jul 81 (manuscript received 23 Jun 80) pp 1449-1457

VDOVIN, V. A. and SOROKIN, Yu. M., Gor'kiy State University imeni N. I. Lobachevskiy

[Abstract] A numerical study is done on different conditions of development of an aerosol plasma microflare in a field of optical radiation of moderate intensity over a rather wide range of initial conditions. The analysis is based on a rough mathematical model that enables investigation of possible conditions of evolution of a microflare around an aerosol particle with considerable latitude of parameters in the given range of simplifications. In this way, the method of successive approximations can be used for numerical analysis of the laser spark, and experimental data can refine the parameters of the approximation on individual stages. It is assumed that the coefficient of absorption of the aerosol material at the frequency of the light field is much greater than that of the ambient gas, that aerosol vapor is close to the surface of the particle at breakdown, that the first ionization potential of the aerosol vapor is much less than that of air, that the velocity of the microflare boundary is much less than the speed of sound in any phase of the system, and that breakdown occurs in a focused beam without appreciable attenuation of the radiation by the microflare. Spatial profiles of the temperature and

coefficient of absorption of the microflare are presented for successive times. It is shown that a stable plasma microflare arises at relatively low intensities of the incident radiation only in the collective mode, i.e. when individual microflares merge. A partial solution is found for the inverse problem of spark dynamics, i.e. determination of the conditions on the surface of an aerosol particle at the instant of arisal of a microflare, and the nature of processes occurring close to this surface from a comparatively small number of measurements of the characteristics of a developed microflare. Figures 3, references 21: 18 Russian, 3 Western.
[258-6610]

UDC 621.378.325

MODE-LOCKING STABILITY OF GARNET LASER

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 7, Jul 81
(manuscript received 18 Aug 80) pp 1535-1537

BATOVRIN, V. K. and NOVOKRESHCHENOV, V. K., Moscow Institute of Radio Engineering, Electronics and Automation

[Abstract] A stability study is done on stimulated emission of a mode-locked garnet laser. It is assumed that there is little change in the duration of the pulses, their phase relative to the modulating voltage, and the gain of the active medium during a single passage of a pulse through the optical cavity. A solution is found for the system of differential equations that describe the time behavior of the duty factor, saturated gain, phase and intensity of the pulsed emission. It is shown that steady-state mode-locked operation in a garnet laser is reached within 10 μs for reasonable parameters, which is considerably faster than relaxational vibrations (230 μs for a YAG:Nd laser), but is close to the period of these oscillations. The mutual proximity of these times can cause loss of stability of mode locking and transition to spike lasing even with a small mismatch between the modulation frequency and the pulse recurrence rate. Calculations and experiments show that the stability region is asymmetric relative to perfect tuning, and that the laser goes into spiked emission as the boundary of the region is crossed. Figures 2, references 5: 3 Russian, 2 Western.
[258-6610]

UDC 621.373.826

SPACE-TIME STRUCTURE OF TURBULENT FLUCTUATION FIELD OF LASER EMISSION

Gor'kiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian
Vol 24, No 2, Feb 81 (manuscript received 2 Jan 80) pp 135-143

BEZVERKHNIY, V. A., GRACHEVA, M. Ye., GURVICH, A. S., LOMADZE, S. O. and POKASOV, Vl. V., Institute of Physics of the Atmosphere, USSR Academy of Sciences

[Abstract] In theoretical analysis of laser intensity fluctuations in a turbulent atmosphere, the time dependence of fluctuations is mainly accounted for by using Taylor's hypothesis of "frozenness" of turbulence. In cases where experimentally observed effects in the space-time structure of turbulence do not yield to such analysis, it is more convenient to use Tatarskiy's concept of "local frozenness" [V. I. Tatarskiy, "Rasprostraneniye voln v turbulentnoy atmosfere" (Wave Propagation in Turbulent Atmosphere), Moscow, Nauka, 1967], which is a generalization of the Taylor hypothesis. The authors give the results of measurements of mutual spectra of intensity fluctuations of laser radiation at two spatially separated points, and compare the resultant data with calculation based on the hypothesis of "local frozenness." It is found that use of this hypothesis enables description of the space-time structure of the field of intensity fluctuations. Formulas derived for calculating the space-time spectrum agree with experimental data for wide beams. Figures 3, references 14: 12 Russian, 2 Western.
[9-6610]

COOPERATIVE RAMAN SCATTERING OF LIGHT

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 81, No 2(8), Aug 81 (manuscript received 21 Jan 81) pp 468-479

PIVTSOV, V. S., RAUTIAN, S. G., SAFONOV, V. P., FOLIN, K. G. and CHERNOBROD, B. M., Institute of Automation and Electrometry, Siberian Department, USSR Academy of Sciences

[Abstract] Experimental research is currently being done on the cooperative emission predicted by R. H. Dicke in 1954. Results of recent studies have shown that analogous phenomena should occur in scattering, i.e. correlation arises between molecules in the process of light scattering, leading to an abrupt change in the characteristics of the scattered radiation as compared with the case of isolated molecules. In particular, a pulse of radiation scattered by correlated molecules should have a certain delay (t_0) relative to the stepped pulse front of the exciting radiation, and also a substructure of a series of short peaks with duration $\tau_0 < t_0$. The authors report on an experimental study of this effect in Raman scattering, which was first observed in 1979. In addition to the common features typical of any cooperative process, cooperative scattering

has some specific peculiarities due to the presence of fields with different frequencies participating in the scattering process. For one thing, scattering occurs simultaneously into two spectral components: Stokes and anti-Stokes. A theoretical analysis is made of four-wave interaction of scattering components and the exciting field, which has a considerable effect on the scattering process. The experimentally observed cooperative Raman scattering is on the $Q_{01}(1)$ line of the hydrogen molecule. The time of the delay of the Raman scattered pulse in coherent unsteady stimulation relative to the maximum of the pumping pulse is inversely proportional to hydrogen pressure and laser power density. The scattered radiation shows intensity pulsations. An analysis is made of the influence that four-wave parametric interaction has on the coherent scattering process. The experimental results agree qualitatively with the theory. Figures 3, references 18: 4 Russian, 14 Western.
[264-6610]

UDC 621.375.826:0.88.8.

KINETIC MODEL OF Ar-N_2 LASER PUMPED BY INTENSE PROTON BEAM

Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 24, No 7, Jul 81 (manuscript received 4 Jun 80, after revision 27 Apr 81) pp 29-33

SULAKSHIN, S. S., Tomsk Polytechnical Institute imeni S. M. Kirov

[Abstract] A numerical analysis is made of a kinetic model of an argon-nitrogen laser with intense proton beam pumping, and the results are compared with experimental data. Gas heating by ions and subsequent relaxation of the plasma in the Ar-N_2 mixture are described by a system of kinetic equations with consideration of the population of levels of the N_2 molecule upon collisions with impinging particles. The charge composition of the beam and pumping by the electronic component of the beam are disregarded. It is shown that direct interaction of the ion beam with nitrogen must be taken into consideration at nitrogen concentrations of more than 20-30%. The channel of recombination drainage of energy from the continuum was found to be much weaker than population by fast particles. Thus, large specific energy inputs to the mixture are possible. Expressions are given for beam energy absorbed in the gas and for the lasing energy. In the experimental verification, the ion beam had a current density of 0.7 A/cm^2 and initial energy of 750 keV. Experimental and theoretical curves are compared for the efficiency and power density as functions of the pressure of the mixture. It was found that the power drops more steeply as pressure rises than predicted by theory. This is attributed to the influence of the mylar separative film in the experiment. The calculated efficiency of 2.8% compares with the experimentally observed value of 1.8±0.2%. The theoretically predicted tendency toward a reduction in efficiency with increasing ion energy is confirmed by experimental data on pumping by collectively accelerated ions. Proton energy reached 1.5 MeV, and efficiency was 0.4%. Analysis of the results shows that it should be possible to make a laser of this type emitting in the ultraviolet at near record power and efficiency. Figures 5, references 13: 8 Russian, 5 Western.
[7-6610]

UDC 621.378.4:635

RESEARCH ON QUANTUM ELECTRONICS AND NONLINEAR OPTICS AT UKRAINIAN ACADEMY OF SCIENCES PHYSICS INSTITUTE (1978-1980)

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 45, No 8, Aug 81 pp 1362-1375

SHPAK, M. T., Institute of Physics, UkSSR Academy of Sciences

[Report to the Tenth All-Union Conference on Coherent and Nonlinear Optics, Kiev, 14-17 October, 1980]

[Abstract] A survey on recent research in quantum electronics, nonlinear optics and holography at the Physics Institute of the Ukrainian Academy of Sciences. Theoreticians have worked on optical orientation of molecules in gas with subsequent deep cooling to the rotational temperature, and have solved the problem of the shape of the radiation-broadened line of an atom with two or more nearly degenerate excited states. Theoretical studies of the magnetic mirror effect in electron-beam-controlled gas lasers have shown that magnetic mirrors can be eliminated by superimposing a longitudinal magnetic field on the discharge that is double the maximum self-field of the plasma current. In nonlinear optics, a technique has been developed for nonlinear conversion of energy to one line in lasers emitting simultaneously on two or more weakly bound transitions. This method appreciably increases the spectral brightness of dye lasers. Systematic research has been done on the effects of self-stress of intense laser beams in semiconductor crystals. Investigations of nonlinear refraction have led to new methods of measuring nonlinear susceptibilities. As a result, it has been possible to find new semiconductor materials with very nonlinear indices of refraction. Experiments with ZnTe crystals have shown emission characteristics of Bose-Einstein condensate. Studies in laser spectroscopy have shown that unstructured one-photon spectra of complex molecules in dye become sharply structured with two-photon excitation. Certain dyes have also shown an effect of absorption saturation in two-step vibronic transitions in the channel of singlet levels. In holography, research on processes of four-wave scattering with wave front reversal has resulted in amplification in cadmium telluride crystals with a high coefficient of reversal. The crystals give holograms with resolution of 400 lines/mm. It has been demonstrated that wavefront reversal can be used to correct laser radiation. A new dye laser has been developed with up-conversion (pumping frequency 1064 nm, lasing on 560-800 nm) and energy conversion efficiency of about 1%. This laser uses two-photon pumping with pulse duration of 1-2 ps, and has a lasing pulse duration of about 0.3 ps. Lasers using cholesteric liquid crystals have been produced with tunable frequency range of 400 nm. Research instrumentation has also been developed at the Institute, including the RIPE-K-2 pyroelectric coordinate-sensitive registration unit for simultaneous measurement of the coordinates and intensity of a radiation beam. Figures 9, references 52: 49 Russian, 3 Western.
[5-6610]

UDC 621.378.4

STIMULATED HARMONICS OF MULTISTAGE NEODYMIUM LASER EMISSION

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 45, No 8, Aug 81 pp 1389-1397

ARIFZHANOV, S. B., GANEYEV, R. A., GULAMOV, A. A., IBRAGIMOV, E. F., REDKORECHEV, V. I. and USMANOV, T., Institute of Electronics imeni U. A. Arifov, UzSSR Academy of Sciences

[Report to the Tenth All-Union Conference on Coherent and Nonlinear Optics, Kiev, 14-17 October, 1980]

[Abstract] The paper gives the results of theoretical and experimental studies of optimization of the process of generation of the second and third harmonics of radiation of a multistage neodymium laser with 45 mm aperture in KDP crystals. Theoretical conditions are found for maximizing conversion to the second and third harmonics. The experiments were done on laser emission of hypergaussian intensity distribution, taking special precausions to get a high-quality beam by using methods of filtration of spatial frequencies, image translation and emission anodizing. The laser consisted of a master oscillator (YAG:Nd^{3+} monopulse laser), a preamplifier and a multistage amplifier. The distribution of the output intensity conformed to the function $I = I_0 \exp[-(r/\alpha)^N]$, where N = 4-6, α is beam radius, and r is the amplitude of the radius vector perpendicular to the z-axis. The energy efficiency with crystals measuring 50 x 50 x 40 mm was 80% for the second harmonic and about 50% for the third harmonic at laser emission energy of 60-70 J. The distribution of intensity for the harmonics at high coefficients of conversion was just as smooth as for the fundamental with lower radiation divergence. Figures 3, references 17: 9 Russian, 8 Western.
[5-6610]

UDC 621.378

WAVEFRONT REVERSAL BY DYNAMIC HOLOGRAPHY TECHNIQUES

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 45, No 8, Aug 81 pp 1403-1411

IVAKIN, Ye. V., ODULOV. S. G., RUBANOV, A. S. and SOSKIN, M. S., Institute of Physics, UkSSR Academy of Sciences, Institute of Physics, BSSR Academy of Sciences

[Report to the Tenth All-Union Conference on Coherent and Nonlinear Optics, Kiev, 14-17 October, 1980]

[Abstract] Research is done on wavefront reversal and its possible applications by methods of dynamic holography. Major emphasis is on new configurations and

mechanisms of the effect, and new nonlinear media for implementation of wavefront reversal in different lasing modes, as well as on new practical applications. The physical principles of wavefront reversal are explained. A wavefront reversal arrangement is described in which dynamic grids are recorded in media with nonlocal response and time dependence of the intensity of the signal and reversed waves. Undoped lithium tantalate crystals are used in this technique with four-beam and three-beam configurations. The light source was a ruby laser with active mode locking. The shutter was an ethanol solution of cryptocyanine. The intensity of the reversed wave drops off sharply beginning with a certain value of the external field due to distortion of the interacting waves caused by self-stress effects. It is shown that loss of synchronism is the main factor responsible for a fall-off of intensity of the signal and reversed waves and an increase in the lasing threshold. The principal use of the effect is compensation for dynamic distortions of laser beam structure. Figures 6, references 26: 17 Russian, 9 Western.
[5-6610]

UDC 621.373.826.038.825.3

EMISSION KINETICS OF FIBER-OPTICS LASER IN PERIODIC GIANT PULSE MODE

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 45, No 8, Aug 81 pp 1435-1442

DZHIBLADZE, M. I., ESIASHVILI, Z. G., LEZHAVA, B. S., TEPLITSKIY, E. Sh. and MSHVELIDZE, G. G., Tbilisi State University

[Report to the Tenth All-Union Conference on Coherent and Nonlinear Optics, Kiev, 14-17 October, 1980]

[Abstract] The needs of optoelectronics require efficient fiber-optics lasers with a broad range of output characteristics and methods of controlling them. The authors investigate the kinetics of stimulated emission of periodic giant pulses in a neodymium glass-fiber laser on 1.06 μm. Q-switching is automatic during lasing due to the properties of the short-lived color centers that arise in the glass matrix as a result of the short-wave component of pumping radiation. Experiments were done at room temperature to study the radiation kinetics as a function of the degree of attenuation of the short-wave part of the pumping spectrum, and at lower temperatures to determine the effect of temperature on emission characteristics. The short-wave component of the pumping spectrum was filtered out by using an aqueous solution of K_2Cr_2O as coolant. It was found that reducing the temperature weakens the influence of short-lived color centers since their absorption band is shifted toward longer waves, reducing the probability of capture of stimulated photons. The influence of these color centers reaches a maximum at temperatures of about 250-300 K, and then begins to decline somewhat. The intensity of superluminescence increases non-exponentially due to the absorption cross section of the color centers. Figures 3, references 7: 6 Russian, 1 Western.
[5-6610]

UDC 621.373.826

FREE-ELECTRON LASERS: MANY-PHOTON TRANSITIONS AND SATURATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 45, No 8, Aug 81 pp 1443-1451

FEDOROV, M. V., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Report to the Tenth All-Union Conference on Coherent and Nonlinear Optics, Kiev, 14-17 October, 1980]

[Abstract] An investigation is made of processes in a free-electron laser in the case of one-particle interaction between beam and radiation, i.e. for $\kappa < 1$ ($\kappa = \omega_b t \gamma^{-3/2}$, where ω_b is beam plasma frequency, t is time of interaction, $\gamma = \varepsilon/mc^2$ is the relativistic factor). It is assumed that amplification on one pass through the optical cavity is small, and consequently the given-field approximation can be used in calculating gains $G < 1$. An expression is derived for linear gain, and different approaches to physical interpretation of processes in free-electron lasers are discussed. Gain-optimum conditions of stimulated emission are found for the Compton laser. Figures 2, references 32: 13 Russian, 19 Western.
[5-6610]

UDC 621.373.8.038.8

PULSE FORMATION IN CO_2 AMPLIFIER WITH SATURABLE ABSORBER

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 45, No 8, Aug 81 pp 1557-1561

AKHMANOV, A. S. and POLYAKOV, G. A., Moscow State University imeni M. V. Lomonosov

[Report to the Tenth All-Union Conference on Coherent and Nonlinear Optics, Kiev, 14-17 October, 1980]

[Abstract] A method is proposed for short pulse formation in CO_2 lasers based on using the optical free induction decay effect. In this technique, the radiation of a single-mode TEA CO_2 laser with narrow spectral line passes through a telescope, and optical breakdown occurs at the focus. The resultant plasma cuts off the pulse with steep fall time of 100 ps or more. This pulse then passes through a spectral filter cell containing CO_2 at 500°C, which absorbs the emission frequency of the main pulse, but passes the harmonic corresponding to the trailing edge. The result is a short pulse with duration depending on the linewidth of the filter and on the coefficient of absorption in the center of the line. The authors study pulse formation in such a laser with amplification length of 5 m. The experimental facility includes the master laser, the pulse shaper, and amplifier with saturable absorber. This laser produces

emission pulses in the P- and R-branches (10.6 and 9.6 μm) with variable duration. Output on the P(20) line of the 10.6 μm band is generated in pulse modes with duration of 100, 20-40 and 1.2 ns with satisfactory repeatibility of pulse shape and energy. The investigation of interaction of IR pulses with duration of 1 ns and polyatomic molecules is of more than theoretical interest. The study of coherent effects observed when short pulses propagate in an amplifying molecular medium is useful both in itself and for developjng large laser systems, e.g. for laser-driven fusion. Figures 4, references 10: 5 Russian, 5 Western.
[5-6610]

UDC 621.378.3

FEASIBILITY OF PARAMETRIC LIGHT GENERATOR BASED ON FOUR-WAVE INTERACTION IN ACTIVE MEDIA

Gor'kiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian
Vol 24, No 6, Jun 81 (manuscript received 21 May 80) pp 719-723

BASHLAKOVA, N. P., BLOK, V. R., KROCHIK, G. M. and KHRONOPULO, Yu. G.,
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[Abstract] In a previous paper [see G. M. Krochik, Yu. G. Khronopulo, KVANTOVAYA ELEKTRONIKA, Vol 5, 1978, p 2065] an examination was made of laser frequency conversion by resonant four-wave interactions in a semi-infinite active medium. The frequency ratios of the interacting waves are $\omega_\ell = 2\omega_p - \omega_s = \omega_{21}$, $\omega_\ell = \omega_s \pm 2\omega_p = \omega_{21}$, where $\omega_{\ell,p,s}$ are the frequencies of the laser, pumping and generated waves, and ω_{21} is the laser transition frequency. It was found that beginning with a certain distance z, the field of frequency ω_s is amplified with an increment in the laser wave even without linear synchronism. This is due to the capture of the phases of the interacting waves in the field of the amplified laser wave. In the present article, the authors consider the feasibility of using these processes for a parametric light generator that is tunable over a wide frequency range. Expressions are derived for the steady-state values of the fields that they approach in the process of laser amplification and simultaneous parametric interaction. Estimates for dye laser parameters show the possibility of developing the proposed parametric light generator emitiing in three wave bands: λ_ℓ = 570-630 nm, λ_p = 650-800 nm and λ_s = 670-2000 nm. Figures 1, references 4 Russian.
[8-6610]

UDC 535.2+535.375.5

WAVEFRONT REVERSAL OF FREQUENCY-SHIFTED WEAK SIGNALS IN INDUCED MANDELSTAM-BRILLOUIN SCATTERING

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 51, No 2, Aug 81
(manuscript received 17 Mar 81) pp 204-207

GYULAMIRYAN, A. L., MAMAYEV, A. V., PILIPETSKIY, N. F. and SHKUNOV, V. V.

[Abstract] In previous research on weak-signal wavefront reversal in Brillouin-Mandelstam scattering, the weak signal and reference wave have been on the same frequency. In this paper the authors study the effect when the weak signal and reference radiation have different wavelengths. It is assumed that the powerful reference wave has a developed speckle structure in the region of interaction, and the process of stimulated Brillouin-Mandelstam scattering is accompanied by wavefront reversal. If a weak signal with given frequency shift relative to the pumping signal is introduced into the reaction region at a small angle to the pumping, interference between the signal and the opposed Stokes wave may generate hypersonic waves. The scattered reference excites a wave that is shifted by the same amount in frequency but in the opposite direction from the weak signal. This is the reversed wave. Formulas are derived for the relative coefficient of reflection of the weak signal as a function of the frequency shift. The results agree with experiment. Figures 2, references 8: 7 Russian, 1 Western.
[6-6610]

UDC 621.373:535.07

FOURTH-ORDER SPATIAL CORRELATION FUNCTIONS OF LASER FIELD

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 51, No 2, Aug 81
(manuscript received 9 Jun 80) pp 332-336

RAKHVALOV, V. V. and STEPANOV, V. A.

[Abstract] In analysis of laser emission coherence, second-order correlation functions are inadequate for describing the properties of nonlinearly converted radiation, and its intensity and statistics are determined mainly by higher-order correlation functions of the primary radiation. The authors consider fourth-order correlation functions and the feasibility of using them in a two-arm experiment. A two-arm Young interferometer with one photosensor is examined to find out how the beats between modes are related to fourth-order correlation functions. Expressions are derived for the correlation function of intensity and fluctuation of intensity with an arbitrary number of transverse modes. The resultant expressions are analyzed for simultaneous emission of four transverse modes of different intensity, and they are compared with the analogous second-order functions. It is shown that fourth-order correlation functions characterize the distribution of beats in the interference field of two beams. One of

the practical applications of fourth-order correlation functions is controlling the purity of stimulated emission of the TEM_{00} laser mode. Analysis shows that the sensitivity of determination of the mode in the most intense part of the beam is considerably greater when a fourth-order coherence function is used instead of other methods. Figures 3, references 5 Russian.
[6-6610]

UDC 621.373:535

FREQUENCY STABILITY OF He-Ne/CH_4 RING LASER

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 51, No 2, Aug 81
(manuscript received 13 May 80) pp 366-368

NIKOLAYENKO, A. N.

[Abstract] An investigation is made of the frequency stability of a ring gas laser stabilized with respect to CH_4 resonance as a function of methane pressure. The measurements were done on a facility consisting of an optical part, an electronic part and a system for pressure regulation of active and passive media. The optical section included two ring lasers, a heterodyne laser, four radiation receivers, alignment lasers, optical decouplers and rotating mirrors. The electronic part contained AFC units for the lasers, amplifiers, laser power supplies, line voltage stabilizers and so on. Optimum stabilization is reached at a methane pressure of about 0.006 mm Hg (about $4.8 \cdot 10^{-14}$). Stability deteriorates at higher and lower pressures. Figures 1, references 9 Russian.
[6-6610]

UDC 621.373:535.(206.3)

HELIUM-NEON LASER (0.63 μm) STABILIZED WITHOUT FREQUENCY DEVIATION

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 51, No 1, Jul 81
(manuscript received 23 Feb 81) pp 10-12

PAK, P. Ye., PRIVALOV, V. Ye. and FOFANOV, Ya. A.

[Abstract] Helium-neon lasers stabilized with respect to saturated absorption in iodine (He-Ne/I_2 lasers) currently hold the record for stability and reproducibility of emission frequency in the visible spectrum. However, these lasers have a linewidth of several MHz due to the frequency deviation required for operation of the AFC system. The authors describe a laser system with stability and reproducibility comparable to He-Ne/I_2 lasers, but with reduced linewidth and continuous frequency tuning. Essentially, this system is an analog of the standard frequency generator in the optical range. Operation of the system is based on heterodyning the output of a Standart-460M He-Ne/I_2

laser with emission from an unmodulated laser. Frequency meters are used to monitor the beat spectrum. Measurements show that stability and reproducibility of the emission frequency are about the same as for the Standart-460M laser, and the linewidth of the unmodulated laser is only 1/30 that of the He-Ne/I_2 laser. Figures 2, references 3 Russian.
[260-6610]

UDC 621.373:535

EFFECT OF EMISSION FREQUENCY SHIFT ON LASER AMPLIFIER EFFICIENCY

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 51, No 1, Jul 81
(manuscript received 31 Mar 80) pp 162-166

GRATSIANOV, K. V., GUBA, B. S., MALININ, B. G., PRILEZHAYEV, D. S.,
RABA, O. B., SEDOV, B. M. and STEPANOV, A. I.

[Abstract] The amplification stages of lasers must meet somewhat contradictory requirements with respect to gain and utilization of stored energy. The optimum combination of properties is a compromise obtained by appropriate choice of the active medium, its dimensions and the pumping conditions. Other factors may also dictate the choice of active medium, for example thermo-optical characteristics and radiation strength. In previous research, a method was proposed for solving these problems by generalization of experimental data [see B. S. Guba, G. V. Obraztsov, D. S. Prilezhayev, B. M. Sedov, ZHURNAL TEKHNICHESKOY FIZIKI, Vol 47, 1977, p 1750]. This method is now extended to cover the case of amplified radiation shifted relative to the amplification maximum, and an investigation is made of the efficiency of amplification systems based on a combination of phosphate and silicate neodymium glasses for different spectral widths and displacements of the amplified radiation. Radiation density was measured by IKT-1M calorimeters. Experimental results are given for laser systems based on GLS-1, GLS-2 and GLS-22 glasses. It is found that spectral characteristics in silicate glass do not agree with calculations, but that the proposed technique of calculating amplifier diagrams is applicable to phosphate glasses even for spectra shifted from the maximum of the luminescence line to the long-wave wing. Figures 4, references 4 Russian.
[260-6610]

UDC 551.561.2:535.311

LASER METHOD OF DETERMINING TURBULENCE PARAMETER C_n^2 BASED ON SCATTERING OF LIGHT BY ATMOSPHERIC AEROSOL

Gor'kiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 24, No 3, Mar 81 (manuscript received 18 Jan 80) pp 298-302

BELEN'KIY, M. S. and MIRONOV, V. L., Institute of Optics of the Atmosphere, Tomsk Affiliate, Siberian Department, USSR Academy of Sciences

[Abstract] A lidar method is proposed for determining the parameter C_n^2 that characterizes the intensity of turbulent pulsations of the index of refraction of atmospheric air. The technique is based on scattering of light by a finely dispersed atmospheric aerosol (haze). The method relies on the phenomenon of turbulence-caused distortion of the spatial coherence of the field of the optical wave scattered by the aerosol, leading to blurring of the image of the scattering volume in the focal plane of the reception lens. It is shown that such a technique does not require placement of the laser source and receiver at different ends of the transmission path. Estimates are made of the potential of the method for determining altitude profiles of C_n^2 in the real atmosphere. It is pointed out that the concept of using an aerosol as a "rotating mirror" in optical measurements of C_n^2 may be useful in remote methods of determining other parameters of the turbulent atmosphere. Both fluctuations of intensity of the reflected wave and random displacements of the image of the scattering volume in the focal plane of the reception lens can be used as the registered radiation characteristics. Figures 1, references 20: 16 Russian, 4 Western. [256-6610]

NUCLEAR PHYSICS

RECENT CONFERENCES ON CONTROLLED NUCLEAR FUSION

European Conference in Moscow

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 15 Sep 81 p 2

[Article by D. Pipko]

[Text] The solution of economic and social problems is inseparably tied up with progress in power production, and the future in this field is related to a great extent to controlled nuclear fusion. Research and development aimed at practical mastery of nuclear fusion is now in sight of the finish line. This explains the heightened interest in the Tenth European Conference on Controlled Fusion and Plasma Physics that opened yesterday in Moscow.

The participants in the conference were greeted on behalf of the Soviet Government by Academician G. I. Marchuk, Deputy Chairman of the USSR Council of Ministers, and Chairman of the USSR State Committee on Science and Technology.

Moscow is rightfully the host to eminent scientists and specialists from twenty-five nations. Everyone knows well the pioneering contribution of Soviet research workers in solving many problems of controlled fusion, breakthroughs in developing facilities of the Tokamak type and other devices.

Of particular interest at the opening conference are survey reports that have been prepared by decision of the International Program Committee. Academician Ye. Velikhov, Vice President of the USSR Academy of Sciences, will present a review of the results of research done in our country. Academician P. Kapitsa will be telling about work done in this field at the Institute of Physical Problems of the USSR Academy of Sciences. V. Alikayev, M. Ioffe, V. Strelkov and V. Shafranov, colleagues of the Institute of Atomic Energy imeni I. V. Kurchatov, will acquaint the audience with research results involving Tokamak facilities, open traps and plasma heating methods. G. Dimov, from the Institute of Nuclear Physics of the Siberian Department of the USSR Academy of Sciences will be telling about research in producing intense beams of negative hydrogen ions. A report by L. Ponomarev will cover the possibilities of "cold" nuclear fusion based on muons produced by so-called meson factories.

A wide range of problems is also dealt with in papers by foreign guests at the conference. G. Griger (West Germany) will give the latest information on the

Intor Tokamak reactor developed by an international group of the IAEA at the initiative of the USSR. Zh. P. Rozhe (Italy) will talk about the Plasma Focus system --a high-intensity source of neutrons, fast electrons and gamma rays. H. Wolf (East Germany), famous for his research on plasma interaction with chamber walls, will give a report on the latest studies in this field. P. Shunka (Czechoslovakia) --a colleague of the Institute of Plasma Physics, CSR Academy of Sciences--will devote a report to problems of interaction of electron beams with plasma.

Although the conference is called "European", it is being attended by scientists from other continents as well. For example, G. Ionas (United States) will talk about attempts to achieve controlled fusion by accelerated light ions. His compatriot N. A. Uchkan will discuss an original toroidal system called the Bumpy Torus. This is one of the few facilities where near steady-state plasma confinement has been demonstrated, although the plasma is not very hot and dense. Doctor Sh. Yamanaka (Japan) will sum up research on so-called inertial nuclear fusion that uses small implosions of tiny deuterium-tritium grains under the action of laser, electron or ion beams rather than magnetic plasma confinement. There will be other papers and reports as well.

Scientists believe that the first experimental industrial power plants with controlled nuclear fusion will appear before the turn of the century. The opening conference is an important step toward this goal.

All-Union Conference in Leningrad

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 28 Jun 81 p 1

[Text] Leningrad, 27 June (TASS Corr.)--The All-Union Conference on Engineering Problems of Nuclear Fusion ended today with a visit to science centers of Leningrad where experiments are being done on controlled nuclear fusion. Taking part in the conference were scientists from our nation, and also physicists from socialist nations, the United States, France, West Germany and Japan.

In summing up the meeting and the current state of the problem, the chairman of the organizational committee of the conference V. Glukhikh, director of D. V. Yefremov Scientific Research Institute of Electrophysical Equipment, said:

"A quarter of a century ago, at the very outset of implementation of projects on conquest of controlled nuclear fusion, our nation pledged itself to keep thermonuclear research on a peaceful basis and to further the cause of international cooperation in this field. Since that time, this pledge has been transformed to specific actions. The address of the Supreme Soviet of the USSR "To Parliaments and Nations of the World" is clear confirmation of the goal-directed peaceful policy of the Communist Party and the Soviet State."

V. Glukhikh went on to say that the conference has demonstrated that a great deal has been done in science. We have learned to control the "behavior" of plasma. We have managed to bring it to a temperature of 70 million degrees, and are approaching the required level of 100 million degrees. We have solved the engineering problems of thermal insulation of fantastic globs of energy. In doing this, extensive use is being made of superconductive magnet systems.

Important strides have been made in developing fusion power reactors. One such advance is the T-15 facility of a new generation of Tokamaks. Within a few years we expect to be able to demonstrate a full-scale controlled fusion reaction for the first time on this facility. Another facility that has been built in Leningrad is the Angara-5 experimental fusion complex with so-called inertial confinement of the plasma.

It would be difficult to enumerate all the engineering-physical and technological design problems that arise in the planning of fusion reactors. Nonetheless, the conference has confirmed the prognosis of specialists to the effect that fusion electric power plants will become a reality on the frontier between this century and the next.

6610
CSO: 1862/1

ELECTRIC POWER BY NUCLEAR FUSION NEAR REALITY

Moscow TRUD in Russian 22 Sep 81 p 4

[Interview with Academician Boris Borisovich Kadomtsev at the Tenth European Conference on Controlled Nuclear Fusion and Plasma Physics in Moscow by I. Mosin; date not specified]

[Text] [Question] Boris Borisovich, to make nuclear fusion controllable, we must learn to attain a temperature of about 100 million degrees, where intense reaction occurs, and to extend the time of plasma confinement in the reactor to a second. How far has science advanced in solving these problems?

[Answer] All specialists agree that "Tokamaks" are currently the most promising and shortest path to fusion electric power plants. These are toroidal installations where the fuel is heated by an electric field and confined in the chamber by a powerful magnetic field. A temperature of about 10-13 million degrees was attained several years ago on the Tokamak-10 facility. Additional means of heating are required to raise the temperature. Unique microwave generators have been developed in Gor'kiy under the direction of Academician Gaponov-Grekhov. These devices have been named gyrotrons.

And here is the latest result. Four gyrotrons have been used on the T-10 to get an electron temperature of up to 30 million degrees in the plasma. Experiments have demonstrated that the heating efficiency is very high, and we can reach an even greater temperature.

The plasma confinement time is also relentlessly approaching the cherished goal. It can be stated that there is not far to go. But the last steps are the hardest. Indeed, over and above the problems that have been mentioned are a number of other technical questions that must be resolved alongside the principal issues. For example making construction materials able to withstand fusion temperatures.

[Question] In 1978, Soviet scientists suggested that the International Atomic Energy Agency [IAEA] unify the efforts of specialists from different nations in the area of nuclear fusion. One of the interesting proposals was the following: development of an experimental fusion reactor that would demonstrate the engineering feasibility of controlled nuclear fusion. What has been done by scientists in the last three years?

[Answer] Work on development of the international fusion reactor (Intor) is proceeding successfully. The IAEA working group involving specialists from various nationa has recently drawn up a feasibility plan for the Intor fusion reactor. Documentation on the project is to be released later this year.

About another year and a half will be required for more detailed analysis of all decisions and for updating the draft with consideration of the latest advances. Building a facility like Intor is a very costly undertaking, and therefore it requires meticulous handling, and careful checking of all details before construction starts. For example, the Soviet Union, Finland and Austria have all proposed that the Intor be built in their country.

As to what the facility will be like, it is assumed that the Intor will be the last step before an industrial reactor, and therefore all its parameters will be as near as possible to the ultimate fusion electric plant. The working volume of the plasma chamber will be more than 200 cubic meters. The current that heats the plasma will reach 6.2 million amperes. A fusion reaction with power of about 600 megawatts will be sustained for 200 seconds.

All physical, engineering and technical aspects will be finally developed on the Intor. The next step will be to develop industrial fusion plants.

[Question] What are the plans for the fusion program in the immediate future?

[Answer] Right now, four very large Tokamaks are under construction around the world. These facilities represent a new and improved generation. In their technical parameters they will be much superior to their predecessors, the Tokamak-10 and Tokamak-7. For example the working volume of the plasma in the new facilities will be tens of cubic meters, which is many times greater than previously.

In the Soviet Union, construction has been started on the Tokamak-15, designed for producing plasma with parameters close to thermonuclear. We hope to use this facility to raise the plasma temperature to 70-100 million degrees at rather high density. The Tokamak-15 is to be the penultimate facility in our nation before an industrial fusion electric plant.

An important step from the engineering standpoint has been successful testing of the T-7 facility, the first Tokamak with superconductive magnet winding. Experiments are still going on at present.

[Question] Scientists are taking different paths to controlled nuclear fusion. Which of them in your opinion is most rapidly approaching the goal?

[Answer] As I have already stated, Tokamaks represent the most promising and shortest road today to fusion power sources. It is this research that is nearest to the target. In a manner of speaking, it is but a stone's throw from the Tokamaks of today to industrial facilities. But the Tokamak is not very simple from the engineering and technical standpoint.

Therefore physicists are doing research in other areas as well. These areas represent a kind of second team, and they include inertial fusion, stellarators, bumpy toruses, compact toroids, inverse pinches and much more. All of them right now are in a state where they cannot be considered serious contenders for the fusion reactor. But some have good prospects.

[Question] The conference has ended, and results have been summarized. What can be said about fusion research in other nations?

[Answer] Scientists have diminishing doubts that a power fusion reactor can be built by the turn of the century. The problem is that it must be economical, competitive and with a variety of uses. The Moscow Conference has been a small but important step to this goal.

From the meetings, reports and discussions at the conference one gets the impression that very intensive research is in progress throughout the world. For example G. Griger of West Germany talked about the latest advances on the Intor, Zh. Razhe of Italy shared the results of experiments on the Plasma Focus system, P. Shunka of Czechoslovakia told about interaction between electron beams and plasma. Six survey papers dealt with research by "non-European" scientists. D. Ionas of the United States talked about attempts to achieve controlled fusion with accelerated light ions. N. Uchkan of the United States discussed an original toroidal system called the bumpy torus. This is one of the few facilities on which it has been possible to demonstrate nearly steady-state confinement, if only in a plasma that is not very hot and dense. A report by Doctor Suzuki of Japan dealt with investigation of methods of heating plasma on the small but very productive Japanese Tokamak.

The level of international cooperation that has been attained over the 25 years since the first straightforward report by I. V. Kurchatov on controlled fusion is an important achievement of all scientists throughout the world engaged with this problem, and an essential factor in final success.

6610
CSO: 1862/10

NUCLEAR REACTIONS IN LASER RADIATION FIELD

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 81, No 2(8), Aug 81 (manuscript received 20 Jan 81) pp 429-433

ZARETSKIY, D. F. and LOMONOSOV, V. V., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] Previous research has shown that processes with low probability in collisions of free atoms or ions may have large cross sections in a field of laser radiation. In particular, induced capture of a neutron with transition of the neutron-nucleus (free-bound transitions) can take place in a sufficiently strong laser field. If the neutron width of this level corresponds to the optical model, the necessary laser intensity for observing induced capture should correspond to values attainable only in pulses with duration of the order of 10^{-9} s. Because of Porter-Thomas fluctuations, the neutron widths of levels of a compound nucleus may differ considerably from the optical model averages. Observed p-levels in the region of resonant neutron energies have anomalously large neutron widths. In this paper, the actual possibility of induced excitation of p-levels is determined by generalizing the theory to the case of induced transition of the neutron-nucleus system from the s-state of the continuous spectrum to the final p-state of the compound nucleus that is also in the continuous spectrum (free-free transitions). An estimate is found for the power of laser emission necessary for observing induced capture of a neutron by a nucleus for known p-levels of the compound nucleus in the region of resonant neutron energies (less than 1 keV). These estimates show that the required laser must have a radiation flux density of at least 10^4 W/cm^2. A pulse laser with this power must act simultaneously with a pulsed neutron source. The target must be transparent to the laser emission and contain a large number of atoms of the investigated isotope. References 6: 5 Russian, 1 Western.
[264-6610]

OPTICS AND SPECTROSCOPY

UDC 537.52

INFLUENCE OF AMBIENT GAS SPECIES AND PRESSURE ON DISCHARGE TEMPERATURE IN ELECTRIC EXPLOSION OF METAL FOILS

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 35, No 2, Aug 81
(manuscript received 31 Mar 80, after revision 17 Feb 81) pp 353-354

BLAGOVESHCHENSKIY, V. V. and MAZURENKO, Yu. T.

[Abstract] Experiments are done to determine the effect that the kind of ambient gas and its pressure have on the temperature of exploding aluminum foil 0.15 mm thick on a mylar backing. The discharge temperature was determined as the maximum value in a pulse. The measurements were made in helium, xenon and nitrogen at pressures up to 10333 GPa. It was found that temperature decreases with increasing molecular weight of the gas at constant pressure. This correlates with an increase in the duration of the current and light pulses. The discharge temperature also decreases monotonically with increasing gas pressure, correlating with increasing duration of current and light pulses. It is concluded that the variety of gas and its pressure can be used to control the brightness temperature of an exploding foil used as a source of intense radiation. Figures 2, references 3 Russian.
[265-6610]

UDC 621.373.8

CALORIMETRIC MEASUREMENT OF METAL MIRROR ABSORPTION FACTOR AT 10.6 μm WAVELENGTH

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 7, Jul 81
(manuscript received 19 Apr 80) pp 4-6

YEGOROV, V. N., NARUSBEK, E. A., YEREMEYEV, G. I. and SHESHUKOV, V. S.

[Abstract] A technique is proposed for precision determination of the absorption factor of highly reflective metallic surfaces in the infrared. Emission from a cw laser on a wavelength of 10.6 μm is incident on the mirror surface in

a calorimeter. The absorbed energy heats the surface and is measured by a thermistor bridge. An electric heater is used for calibration. Thermal losses are minimized by using a specimen holder with only steel needle points in contact with the mirror. The radiation receiver is a massive copper cylinder with tapered inner surface coated with a mixture of graphite powder and heat-resistant lacquer. The measurement instrumentation permits simultaneous determination of the temperatures of calorimeter and radiation receiver every 10 s. The procedure for determining absorption from the temperature curves is explained. Measurement results are given for five copper and bronze mirrors. The lowest coefficient of absorption was shown by a Br Tsr bronze specimen with 4-layer dielectric coating, which had an average absorption factor of 0.00423. The absolute error of measurement in this case was 5.2%. Figures 3, references 12: 6 Russian, 6 Western.
[268-6610]

UDC 53.082.5

CHECKING ANGULAR ERRORS OF OPTICAL PRISMS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 7, Jul 81 (manuscript received 8 Oct 79) pp 14-15

TAREYEV, A. M. and TRONYAK, B. D.

[Abstract] In checking angular errors of prisms with reflective faces where the angle of incidence of light is less than the angle of total internal reflection, the inspection is usually done after coating. If precision requirements are high, and the reflective coating is expensive, it would be best to do the check before coating. In this article it is shown that this can be done by placing a flat mirror parallel to the face to be coated during the optical check. Conditions to be met for minimizing errors when using such a method are given, and a mechanical device for ensuring these conditions is described. Figures 3, references 2 Russian.
[268-6610]

UDC 534.222

RANDOM SHIFTS OF OPTICAL BEAMS IN AEROSOL ATMOSPHERE

Gor'kiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 24, No 2, Feb 81 (manuscript received 18 Jan 80) pp 144-150

LUKIN, I. P., Institute of Optics of the Atmosphere, Siberian Department, USSR Academy of Sciences

[Abstract] Propagation of a bounded light beam in a randomly inhomogeneous medium gives rise to chaotic shifts of the beam as a whole. Although considerable research has been done on the variance and correlation functions of such displacements in a turbulent atmosphere, these studies have disregarded the influence of the aerosol that is always present and takes an active part in light scattering. In this paper, the statistical characteristics of displacements of a light beam propagating in a turbulent atmosphere containing an aerosol are studied in the model approximation of a continuous randomly inhomogeneous medium. The model is assigned by a set of moment functions of permittivity. Conversion from the discrete to the continuous model is based on the assumption that the particles of the medium are weak (soft) scatterers. Cases of both weak and strong intensity fluctuations are analyzed. Figures 2, references 11 Russian.
[9-6610]

UDC 621.378.325

INTENSE WAVE BEAM PROPAGATION IN NONLINEAR MEDIUM

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 45, No 8, Aug 81 pp 1422-1428

AMOSOV, A. A., BAKHVALOV, N. S., VLADIMIROV, M. V., VLASOV, D. V., ZHILEYKIN, Ya. M., KOROBKIN, V. V., PROKHOROV, A. M. and SEROV, R. V., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Report to the Tenth All-Union Conference on Coherent and Nonlinear Optics, Kiev, 14-17 October, 1980]

[Abstract] Preliminary calculations of beam propagation with plateau intensity distribution have shown that propagation of non-gaussian beams in a nonlinear medium differs appreciably from the case of beams with gaussian profile. In this paper, numerical methods are used for a systematic study of propagation of non-gaussian wave beams in nonlinear media. The initial model for the computer simulation is a parabolic equation. It is assumed that electric field intensity is distributed with axial symmetry in the wave beam, and depends only on coordinates r and z. The field distribution is also taken as quasi-steady in time. The analysis is based on media of Kerr type in which

the index of refraction depends on field intensity E as $n = n_0 + n_2E^2$. Saturation of nonlinearity of the index of refraction was disregarded. Three-photon absorption was introduced as a constraint on maximum power density. The results show three major differences from gaussian beam propagation: 1. linear diffraction distorts the profile of transverse distribution, forming annular zones; 2. the resultant rings have an appreciable effect on the nature of beam propagation in nonlinear media; 3. the annular zones are pulled toward the center with formation of a single focus from each zone, through which the power flux is considerably greater than critical. The technique of numerical analysis used in this paper cannot give any final conclusions about the stability of collapse of the annular zones. Three-dimensional calculations of intense wave beam propagation in a nonlinear medium are now being done to solve this problem. Figures 7, references 5 Russian.
[5-6610]

UDC 535.317.1

USING REFLECTIVE HOLOGRAMS TO STUDY DIFFUSE SURFACE RELIEF

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 51, No 2, Aug 81 (manuscript received 15 May 79, after revision 15 Nov 80) pp 337-341

BOGOMOLOV, A. S.

[Abstract] Previous research has demonstrated the feasibility of using volumetric reflective Denisyuk holograms in holographic interferometry, and in particular for getting a topographic map of the surface of an object. The author describes experiments on determining the contrast of a reflective topogram produced by a two-source technique, and the sensitivity of an immersion reflective topogram. Period and contrast of interference bands were studied on topograms taken by both methods of a bas relief and a polished surface. It is shown that high-aperture reflective topograms can be obtained in a one-beam Denisyuk arrangement with sensitivity $H_1 \geqslant 24$ μm by the two-source method, and $H_2 \geqslant 8.6$ μm by the immersion method. White light can be used for reconstruction. Brightness is enhanced by using a slightly convergent beam in reconstruction. Figures 3, references 11: 5 Russian, 6 Western.
[6-6610]

UDC 535.345.1+535.417

SYNTHESIZING COATINGS WITH LOW REFLECTIVITY IN PREDETERMINED SPECTRAL REGIONS. SYNTHESIZING ANTIREFLECTION COATINGS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 51, No 2, Aug 81
(manuscript received 14 Mar 80, after revision 15 Dec 80) pp 353-357

FURMAN, Sh. A. and SLOTINA, N. M.

[Abstract] Results of calculations for specific types of antireflective coatings are analyzed on the basis of a method of synthesis proposed in a previous paper [see Sh. A. Furman, N. M. Slotina, OPTIKA I SPEKTROSKOPIYA, Vol 51, 1981, p 177]. Tables are given summarizing the major parameters of multiple-layer achromatic antireflecting coatings 2P2AN, 3PA2VN and 5PDSA2VN. Figures 2, references 2 Russian.
[6-6610]

UDC 535.36

STUDYING OSCILLATIONS OF MOVING ROUGH BODIES BASED ON THE LIGHT THEY SCATTER

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA
in Russian Vol 22, No 3, May-Jun 81 (manuscript received 28 May 79) pp 25-28

ANCHUTKIN, V. S. and SHMAL'GAUZEN, V. I., Department of General Physics and Wave Processes, Moscow State University imeni M. V. Lomonosov

[Abstract] The authors consider the use of differential interferometry for studying vibrations of an object with a rough surface. In this case, the scattered light field is a speckle structure cut by a system of interference bands with period determined by the geometry of the problem. The phase of the bands is a random quantity associated with the statistical properties of the surface. A formula is derived for the signal at the output of the photocell in the interferometer in the case where the spatial filtration of the scattered field is by a harmonic grid-mask for a rough surface that is vibrating and moving parallel to itself. This formula is analyzed for harmonic vibrations of the surface with known frequency. Experiments are done to study the feasibility of this technique for an object vibrating with amplitude much greater than the wavelength of the incident light. The main element in the differential interferometer was a grating with reflecting lines and transparent spaces between them. The moving specimen was a rotating Duralumin disk. Harmonic vibrations were produced by tilting the axle of the disk. Spectrograms of the output signal of the photocell are given for the wobbling disk. Recommendations are made on optimizing the geometry of illumination. The results show that this is an effective technique for detecting small transverse oscillations of a moving object, and especially angular wobble of rotating parts. Experimental and theoretical data are in good agreement. Figures 3, references 6: 5 Russian, 1 Western.
[255-6610]

UDC 538.56:519.25

CORRELATION FUNCTION OF INTENSITY FLUCTUATIONS OF GAUSSIAN OPTICAL BEAM IN RANDOM MEDIUM WITH LARGE-SCALE DISCRETE SCATTERERS

Gor'kiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 24, No 3, Mar 81 (manuscript received 31 Jan 80) pp 314-321

KRUTIKOV, V. A., Institute of Optics of the Atmosphere, Tomsk Affiliate, Siberian Department, USSR Academy of Sciences

[Abstract] An analysis is made of correlation properties of intensity fluctuations as optical radiation propagates in a turbulent medium that contains large-scale inhomogeneities. It is shown that the statistical characteristics of a beam propagating in such a medium characterized by turbulent permittivity fluctuations can be found by independent calculation of the sought characteristics for turbulent and discrete inhomogeneities assuming appropriate conditions of propagation. An analysis is made of results of numerical calculations of the correlation function for different configurations of optical beams with different conditions of registration. It is concluded from the results that the proposed method of calculating statistical properties of gaussian beams enables utilization of the statistical moments of intensity fluctuations, and also quantitative determination of the level and correlation properties of intensity fluctuations of optical beams in a variety of geometries and conditions of propagation. Figures 7, references 7 Russian.
[256-6610]

UDC 621.371.24

SATURATION EFFECT OF COHERENCE FUNCTION OF WAVE REFLECTED FROM DISCRETE SCATTERERS IN TURBULENT ATMOSPHERE

Gor'kiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 24, No 3, Mar 81 (manuscript received 25 Mar 80) pp 322-325

KRUPNIK, A. B. and SAICHEV, A. I., Scientific Research Radio Physics Institute

[Abstract] Considerable research has been done previously on the statistical characteristics of electromagnetic waves reflected from obstacles in a randomly inhomogeneous medium. One of the reasons for these studies has been the effect of backscattering amplification. This paper considers another effect characteristic of backscattering: saturation of the coherence function of a monoenergetic wave reflected from a layer of discrete scatterers in a large-scale randomly inhomogeneous medium. It is shown that the coherence function approaches a steady-state level as the thickness of the layer of scatterers increases. References 5: 4 Russian, 1 Western.
[256-6610]

UDC 778.38;535.853.31

ABERRATIONS OF CONCAVE HOLOGRAPHIC DIFFRACTION GRATINGS OF THIRD TYPE IN ULTRAVIOLET REGION OF SPECTRUM

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 6, Jun 81
(manuscript received 17 Jun 80) pp 8-10

STOZHAROVA, K. A.

[Abstract] There has recently been an upsurge of interest in the use of diffraction gratings produced by holographic methods in spectral instruments. Especially useful for these purposes are concave holographic diffraction gratings that are simultaneously dispersing and focusing elements, which is important for spectral instruments operating in the ultraviolet and infrared. In this paper a detailed analysis is made of aberrations of gratings in this category of the third type in accordance with Jobin-Yvon classification. Studies are done over a broad spectral range of the ultraviolet from 50 to 400 n. A distinguishing feature of holographic concave gratings of the third type is the presence of three stigmatic points, i.e. where the image is aberrationless. To get a grating of this kind, point sources of radiation must be located on a straight line passing through the center of curvature of the spherical surface of the backing. In imaging the spectrum of a polychromatic light source, the source must be placed on this line. Transverse aberrations were calculated in the first-order spectrum for two versions of source location: at the center of curvature of the grating, and at a given stigmatic point. The calculations were done for gratings of 600, 1200 and 1500 lines/mm. It was found that abberations increase with increasing line frequency, but the behavior of the abberations in the direction of dispersion due to residual defocusing in the spectrum considered on the sagittal focal curve. An analysis of aberrations of these gratings in the spectrum formed on the meridional focal curve with the source at the center of curvature shows that resolution is much higher, but scanning is difficult because of the complicated shape of this curve. These gratings produce no astigmatic elongation of the image in focusing on the plane. Figures 3, tables 1, references 5: 1 Russian, 4 Western.
[259-6610]

UDC 778.385.35.853.31

REFLECTIVE HOLOGRAPHIC DIFFRACTION GRATING

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 6, Jun 81
(manuscript received 15 May 80) pp 53-54

MARKOVSKI, P., TODOROV, T., SHARLANDZHIYEV, P. and RAZSOLKOV, V.

[Abstract] A simple method is described for making reflective holographic diffraction gratings with high diffraction efficiency and with a single

diffraction order. Transmitting volume phase holograms have only one diffraction order, high angular selectivity in reconstruction, and diffraction efficiency that depends on the phase modulation of the light-sensitive medium. Light falling on these holograms is diffracted by the periodic structure. If the dispersed light is reflected in such a way that it passes through the hologram a second time, but at an angle different from the Bragg angle, a reflected spectrum of the light incident on the hologram is produced. This can be done by orienting the lines of a phase grating obliquely to the surface. A holographic grating is recorded in a standard two-beam arrangement (argon laser, wavelength 488 nm) with two planar wave fronts forming an angle of 16.83°. Spatial frequency was 660 lines/mm. The photosensitive emulsion was bichromated gelatin in a layer 20 µm thick on a plane-parallel plate. The plate was oriented so that the normal to its surface was not on the bisector of the angle formed by the wave vectors of the two light beams. After development in isopropyl alcohol, the resultant transmitting grating was sputtered with a dense metal coating on the gelatin side. Light incident on the resultant reflective grating is diffracted by the phase structure, reflected from the metal layer, and passes again through the grating without diffraction, since the lines of the grating are not perpendicular to the surface. Focusing gratings can be made by the same technique. Figures 1, references 4 Western.
[259-6610]

UDC 621.372.2.001.24

APPLICATION OF V. L. RVACHEV'S METHOD TO THEORY OF SIGNAL FILTRATION AND PATTERN RECOGNITION

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 259, No 4, 1981
(manuscript received 16 Oct 80) pp 823-825

ZUBKOV, Yu. P., KRAVCHENKO, V. F. and NEFEDOV, Ye. I.

[Abstract] There is a current trend toward greater redundancy in many fields of data processing: communication theory uses error-correcting codes to improve transmission reliability, pattern recognition theory uses information redundancy to solve classification problems. An important practical problem in these cases is that of optimum processing of signals that contain redundancy. In this paper a new method is proposed that uses the theory of R-functions [Rvachev, V. L., "Metody algebry logiki v matematicheskoy fizike" (Methods of Logic Algebra in Mathematical Physics), Kiev, Naukova dumka, 1974] to describe regions of identification of signal points for synthesis of practically realizable reception algorithms for signals with redundancy as a whole, enabling effective solution of an extensive class of problems of image enhancement and restoration in the theory of pattern recognition. The principal distinguishing feature of the new technique is the use of a structural method for describing predicate equations of regions of identification of signal points in different procedures for processing signals and images. The proposed concepts can be generalized to a number of problems of nonlinear image processing and signal filtration. References 7 Russian.
[266-6610]

PRIZ IMAGE CONVERTER AND ITS USE IN OPTICAL DATA PROCESSING SYSTEMS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 7, Jul 81
(manuscript received 18 Jun 80) pp 1422-1431

PETROV, M. P., KHOMENKO, A. V., KRASIN'KOVA, M. V., MARAKHONOV, V. I. and
SHLYAGIN, M. G., Physicotechnical Institute imeni A. F. Ioffe,
USSR Academy of Sciences, Leningrad

[Abstract] The paper describes the PRIZ image converter, an improved optically controlled space-time light modulator for real-time processing of large volumes of two-dimensional images by optical methods. The PRIZ system has high parameters and enables simple and effective spatial differentiation and sectoral filtration, and in addition is capable of dynamic image selection, enabling discrimination of the time-variable part of two-dimensional data files. Operation of the modulator relies on the photorefraction effect, i.e. the change in birefringence of a crystal under the action of incident light. This is the same principle that is used in the PROM modulator. The differences between the two devices are explained in terms of the theory of the electro-optical effect for crystals of the given type. Optimum parameters are obtained on a crystal of $Bi_{12}SiO_{20}$, although experiments were done with $Bi_{12}GeO_{20}$ and $Bi_{12}TiO_{20}$ as well. The working principle is analyzed in detail, and results of measurement of parameters are given. It is shown that the PRIZ is superior to the PROM with the same crystal with respect to all major parameters. A new method is proposed for describing the effect of dynamic light modulators, which is applicable to description of the effect of dynamic image selection observed in the PRIZ modulator. It is shown that holograms can be recorded from such a modulator. Figures 8, references 11: 8 Russian, 3 Western.
[258-6610]

LASER PULSE RECORDING OF OPTICAL INFORMATION ON SMECTIC-A LIQUID CRYSTALS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 7, Jul 81
(manuscript received 29 Feb 80, after revision 30 Dec 80) pp 1529-1534

KLYUKIN, L. M. and NESRULLAYEV, A. N., All-Union Scientific Research Institute
of Optical and Physical Measurements, Moscow

[Abstract] The authors determine the principal optical parameters of smectic-A liquid crystals as a photographic medium: frequency-contrast characteristics and spatial resolution, number of distinguishable half-tones, threshold sensitivity, maximum permissible energy density, and dynamic range under conditions of thermal registration. Three binary mixtures were studied: 45 wt.% 4-n-pentyl-4-cyanobiphenyl + 55 wt.% 4-n-hexylphenyl-4-butylbenzoate, 80% 4-n-octyl-4-cyanobiphenyl + 20% 4-n-decyl-4-cyanobiphenyl, and 35% 4-n-octyl-4-cyanobiphenyl + 65% 4-n-hexylphenyl-4-butylbenzoate. The optical parameters of these mixtures were studied by registration of a bell-shaped reference pulse, and by image transfer. Spatial resolution is as high as 100 lines per mm, with

contrast of 20:1 with almost no change after 100 recording-erase cycles. Storage time is at least 1.5 years without appreciable deterioration of image parameters. Although smectic-A liquid crystals have comparatively low sensitivity, recording and readout with such media is far simpler than with magnetic tape having similar parameters. Figures 6, tables 2, references 9: 4 Russian, 5 Western.
[258-6610]

UDC 535.41

STRUCTURE OF OPTICAL IMAGE IN COHERENT LIGHT

Gor'kiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 24, No 6, Jun 81 (manuscript received 31 Mar 80) pp 748-752

LOKSHIN, G. R., KOZEL, S. M. and BELONUCHKIN, V. Ye., Moscow Physicotechnical Institute

[Abstract] A theoretical analysis is made of the light wave scattered by a coherently illuminated object and of the behavior of its structure during passage from the object to the plane of observation. It is shown that a sharply focused image exists in latent encoded form in any plane of observation arbitrarily distant from the object, and can be reconstructed from a discrete set of harmonics. An optical filter is proposed for decoding such information. Conditions are determined for limiting distortions to the magnitude of diffraction distortions. References 2 Russian.
[8-6610]

UDC 531.317.1

PLANAR WAVEGUIDE-FIBER OPTICS CHANNEL FOR HOLOGRAPHIC MEMORIES

Gor'kiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 24, No 6, Jun 81 (manuscript received 13 Nov 80) pp 759-762

BYKOVSKIY, Yu. A., KUL'CHIN, Yu. N. and SMIRNOV, V. L., Moscow Engineering Physics Institute

[Abstract] Practical high-efficiency light deflectors combined with lens systems in planar waveguides enable localization and extraction of emission propagating in a thin-film waveguide based on the effect of optical tunneling of luminosity into a fiber-optics line at any point of the plane. The combination of integrated fiber-optics systems and holography could be a basis for fundamentally new optical data processing systems. In this paper an investigation is made of the possibilities for recording and reconstruction of Fourier holograms with high information density using a planar waveguide-fiber optics system with interfacing of the fiber-optics lines. Planar waveguides were

made by the method of ion substitution in molten salt $AgNO_3$ on a glass backing. The optical fibers had a core of As_2S_3 in a glass sheath. These fibers were coupled to flexible quartz fibers capable of carrying the extracted radiation to any predetermined point. The proposed system can be used for recording and readout of information with a density of 10^4 bits/mm^2. The reference beam is coupled into the planar waveguide by a TF-5 glass prism, and extracted through the optical fiber with the end ground to an acute angle ensuring conditions of phase synchrony of waveguide and fiber modes. Each waveguide permits propagation of 7 modes of both TE and TM polarization. The properties of the experimental device do not reflect the limits of such holographic memories, and can be improved by optimization studies. Figures 3, references 5 Russian.
[8-6610]

PLASMA AND CURRENT STRUCTURES IN DYNAMIC Z-PINCHES

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 81, No 2(8), Aug 81 (manuscript received 30 Dec 80) pp 560-571

BUTOV, I. Ya. and MATVEYEV, Yu. V.

[Abstract] The paper gives experimental data on the dynamics of plasma shells in a Z-pinch device during the time from gas breakdown to the second singularity. The experiments were the first to show such effects in Z-pinches as explosive formation of current shells, multiplicity of current loops in a compressed plasma, and dissociation of the expanding plasma into current filaments. At initial pressures greater than 0.1 mm Hg, current shell compression is best described by the magnetic piston-shock wave model. At lower pressures, the snowplow model is more applicable. It is shown that the second and subsequent singularities observed on the discharge current are related to drift motion of light plasma shells toward the axis (shunting breakdowns). A new form of MHD activity is observed in coaxial layering of the Z-pinch and ejection of surface shells without disturbing the equilibrium of the plasma column. As the magnetic piston is compressed by the reflected shock wave, interaction of the resultant current loops fills the region outside the core of the pinch with plasma and currents that alternate in direction. The current registered in the loops is 1.5-2 times that in the power supply circuit. These effects arise as superheating instability develops, and may be observable in theta pinches, plasma focuses and tokamaks. Figures 8, references 19: 16 Russian, 3 Western. [264-6610]

NONLINEAR THEORY OF BUNEMAN INSTABILITY

Mosocw ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 81, No 2(8), Aug 81 (manuscript received 3 Feb 81) pp 572-580

GALEYEV, A. A., SAGDEYEV, R. Z., SHAPIRO, V. D. and SHEVCHENKO, V. I., Institute of Space Research, USSR Academy of Sciences

[Abstract] The technique of studying nonlinear dynamic instability based on the weak turbulence approximation is not applicable to instabilities with rigid excitation such as Buneman instability due to negative pressure in an electron flux that moves relative to ions at greater than thermal velocity. The nonlinear dynamics of this instability is intimately involved with the problem of formation of double layers in the plasma that is penetrated by the electron flux. Such layers are regions of charge separation with dimensions of the scale of the Debye radius where the electric potential varies by a considerable amount comparable with or greater than the thermal energy of the particles. The authors find exact nonlinear solutions that describe the evolution of Buneman instability for arbitrary initial conditions. It is shown that under certain initial conditions, solutions are possible with an explosive growth of electric potential with time, in agreement with self-similar solutions found previously. Figures 3, references 6: 4 Russian, 2 Western.
[264-6610]

UDC 538.56:533.90

EFFICIENCY OF GENERATION OF SURFACE WAVES IN PLASMA-BEAM SYSTEMS

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA in Russian Vol 22, No 3, May-Jun 81 (manuscript received 23 Jun 80) pp 90-92

GRISHIN, V. K. and KANEVSKIY, M. F., Department of Nuclear Interactions and Accelerators, Moscow State University imeni M. V. Lomonosov

[Abstract] An examination is made of efficiency of stimulating a surface E-wave in plasma-beam systems in two typical situations: 1. a broad relativistic electron beam sweeps over a plasma surface that is free of any magnetic field; 2. the beam sweeps over a narrow plasma column of known radius, where both beam and plasma are magnetized. Formulas are derived for efficiency of conversion of beam energy to radiation energy (the ratio of the radiation flux to the flux of initial kinetic energy of the beam) in both cases. Self-consistent nonlinear kinetic analysis yields equations for the beam velocity in the final state as a function of initial parameters of beam and plasma for surface and column configurations. It is shown that the efficiency of generation of a wave field can be considerably increased by using beam sweep as compared with penetrating beams at the same beam intensity, with simultaneous reduction of losses in the plasma. Figures 1, references 3 Russian.
[255-6610]

UDC 533.922

NONLINEAR KINETIC WAVE-BEAM EQUILIBRIUM IN DECELERATING SYSTEMS

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA
in Russian Vol 22, No 3, May-Jun 81 (manuscript received 10 Jul 80) pp 95-98

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[Abstract] Interaction between a beam and a stimulated electromagnetic wave generally leads to beam instability in which the final stage may be stabilization of energy exchange (equilibrium conditions) between wave and beam. An analysis is made of this equilibrium based on exact solutions of a self-consistent nonlinear kinetic equation, and on a complete system of conservation laws, thus eliminating some inconsistencies in the physics of the process that have shown up in previous research. The model of the decelerating system is a waveguide with dielectric filler ($\varepsilon > 1$). A monoenergetic beam with given initial velocity magnetized in the transverse plane is continuously injected into the waveguide, and interacts with an electromagnetic perturbation, causing amplification. An analysis is made of the interaction of particles with a purely harmonic E-wave with a given longitudinal component of the electric field. Major characteristics of the system in the equilibrium state are found: the dispersion equation, efficiency of conversion of the kinetic energy of the beam to field energy, and the coefficient of capture of particles. Figures 1, references 4 Russian.
[255-6610]

MATHEMATICS

UDC 517.92

PURSUIT BY SEVERAL CONTROLLED OBJECTS WITH PHASE CONSTRAINTS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 259, No 4, 1981
(manuscript received 6 Mar 81) pp 785-789

PSHENICHNYY, B. N., CHIKRIY, A. A. and RAPPOPORT, I. S., Institute of Cybernetics, UkSSR Academy of Sciences, Kiev

[Abstract] An analysis is made of the problem of pursuit by several controllable vehicles where the terminal set has a special form that enables coverage of the situations where phase constraints are imposed on the state of the object of pursuit. The pursuit problem with phase constraints reduces to a problem of pursuit without constraints but with another terminal set. The proposed method of finding sufficient conditions for completion of the game in a finite time is an extension of the ideas of a previous paper by these same authors [see DOKLADY AKADEMII NAUK SSSR, Vol 256, No 3, 1981]. It is shown that in some cases it is possible to calculate the controls of the pursuers and to evaluate the time of completion of the game. The results are illustrated by a model example. References 8 Russian.
[266-6610]

EVASION PROBLEM WITH INFINITE SEQUENCING MACHINES

Baku IZVESTIYA AKADEMII NAUK AZERBAYDZHANSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH I MATEMATICHESKIKH NAUK in Russian Vol 2, No 3, May-Jun 81
(manuscript received 26 Feb 81) pp 15-20

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[Abstract] This game problem is analyzed from the standpoint of a positional game. In such a game, the strategy of the players at each instant depends on the current state of the system. Construction of positional strategies is called synthesis of a system. Formulation is interpreted as follows. In the space of positions $\{n, s\}$. The first player attempts to reach set M in a

minimum time, and the second player attempts to prevent this. An arbitrary infinite field is given, and a linear sequencing machine is defined over this field for which the synthesis problem can be solved. It is assumed that each player has access to such a machine, and the functional that describes the quality of the game is given. It is the first player's task to minimize this functional, while the second player must maximize this functional. The game is completed when the distance between vectors defining the state of the game for the two players on a given step is less than a preassigned positive number. The problem is solved by a dynamic programming method for the case of complete information of both sides. Finding the optimum strategies for the two players reduces to solution of paired problems of optimum control for the linear sequencing machines. Figures 1, references 8 Russian.
[11-6610]

UDC 519.7

SENSITIVITY OF NONLINEAR UNSTEADY SEQUENCING MACHINES

Baku IZVESTIYA AKADEMII NAUK AZERBAYDZHANSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH I MATEMATICHESKIKH NAUK in Russian Vol 2, No 3, May-Jun 81 (manuscript received 26 Jan 81) pp 101-105

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[Abstract] The author investigates problems of sensitivity of nonlinear unsteady sequencing machines. The principal ideas of sensitivity analysis in this case are the same as those used for continuous and discrete systems. The equations of state are given that define the sequencing machines. Processes of finite duration are considered, using a variational approach that broadens the generality of the sensitivity concept. Conditions of weak and strong insensitivity are defined and analyzed. References 3 Russian.
[11-6610]

METHOD FOR SOLVING PROBLEM OF IDENTIFYING NONLINEAR STATIC OBJECTS

Baku IZVESTIYA AKADEMII NAUK AZERBAYDZHANSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH I MATEMATICHESKIKH NAUK in Russian Vol 2, No 3, May-Jun 81 (manuscript received 9 Feb 81) pp 106-110

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[Abstract] A solution is found for the problem of identifying static objects with nonlinear parameters by methods of global optimization, and specifically by random search methods, since these methods usually do not involve finding the vector of initial parameters, and the initial conditions may be arbitrarily

assigned. The problem is formulated, and it is demonstrated that it can be categorized as a multiple-extremum problem. The given model of the object is a nonlinear programming problem without constraints. The solution is found by the method of "controlled perturbation" proposed by these authors in the book "Optimizatsiya tekhnicheskikh sistem" [Optimization of Technical Systems], Novosibirsk, 1976. In this procedure it is assumed that "noise" is introduced into the parameters of the object by some external perturbation. A certain additive control is then introduced into the "noisy" gradient motion that compensates for the action of the external random perturbation on the functional to be minimized, this compensation being complete at the point of the global extremum. Continuous and discrete versions of the search algorithm for solution by the proposed method are given. It is shown that global methods considerably accelerate the processes of evaluating the parameters of the object, and eliminate the need for cumbersome procedures in finding the initial vector. References 5 Russian.
[11-6610]

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